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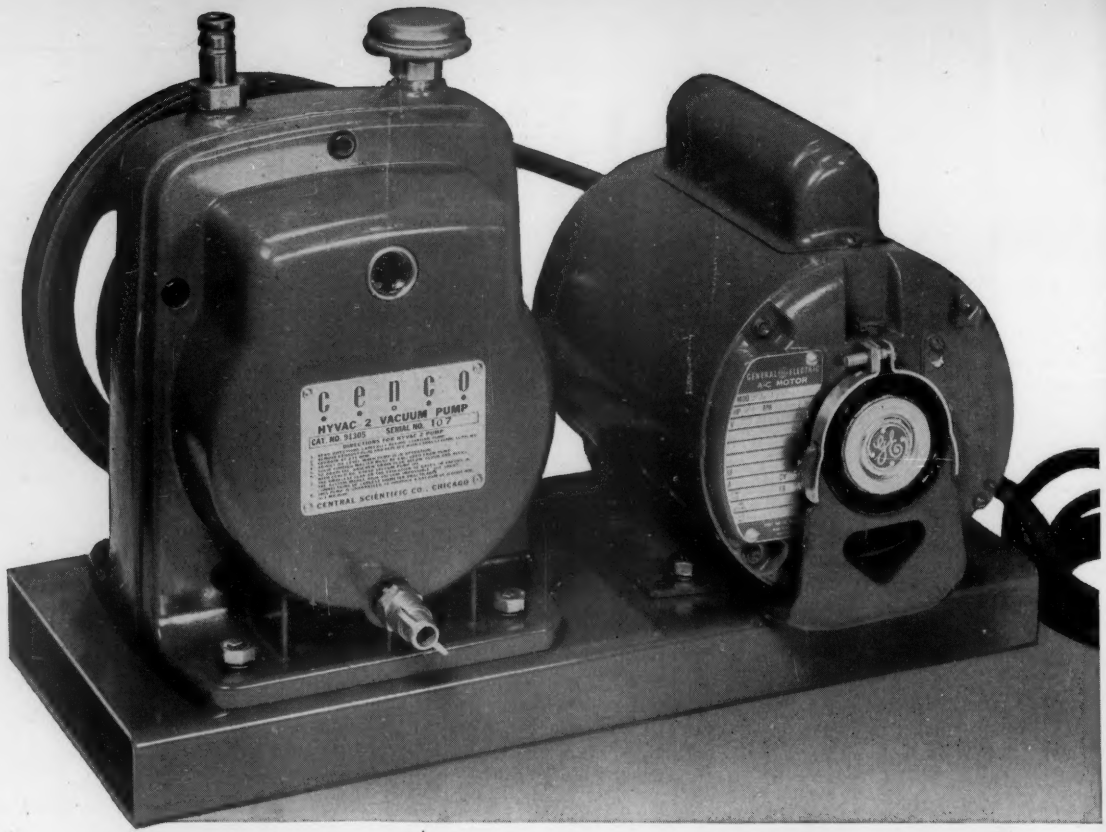

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Centennial of Discovery of Neanderthal Man

The type specimen of Neanderthal man, that extinct relative of modern man, was discovered by workmen in a cave overlooking the Düssel River between Elberfeld and Düsseldorf, Germany, during the summer of 1856, hence just 100 years ago, and just 3 years before the publication of Charles Darwin's *On the Origin of Species*. Actually, this specimen does not represent the earliest known discovery of the Neanderthal variety of man; for an unusually well preserved skull of that category had been found 8 years earlier, in 1848, in Forbes Quarry, on the Rock of Gibraltar, by Lieutenant Flint of the Royal Artillery, who presented it to the Gibraltar Scientific Society.

The Gibraltar skull, however, remained unnoticed until after its arrival in England in 1862. Hence the German skeleton of 1856 represents the first specimen of an extinct form of man that was subjected to serious scientific study. For some time after its discovery, this specimen was the subject of bitter controversy. Some scientists regarded it as a true fossil. Others, however, considered it to be nothing more than a pathological modern human skeleton. Indeed, one diagnosis labeled it the rachitic skeleton of a Cossack from the Napoleonic Wars! The scientific world was not yet fully prepared to embrace the concept of "antediluvian" man.

It is now quite clear, however, from numerous specimens subsequently discovered in Belgium, France, Germany, Italy, Morocco, Palestine, Uzbekistan, and other localities, that the type Neanderthal remains are those of a distinct and now extinct variety of man that was widely spread over Europe, western Asia, and North Africa during the third interglacial and fourth glacial phases of the Pleistocene epoch or Ice Age. His major anatomical characters are well known. Although his precise relationship to the modern type of man and, hence, his exact phylogenetic status remain unsettled questions, his significance for the science of paleoanthropology remains undiminished. He was, in the words of the late Earnest Hooton, "Darwin's first witness" for human evolution.

It is therefore fitting that a symposium on Neanderthal man, to celebrate the centennial anniversary of the discovery of the type specimen, jointly sponsored by Section H of the American Association for the Advancement of Science and the American Institute of Human Paleontology, is scheduled for the morning of 27 December during the forthcoming annual meeting of the AAAS in New York.—WILLIAM L. STRAUS, JR., *Johns Hopkins University*, and LOREN C. EISELEY, *University of Pennsylvania*

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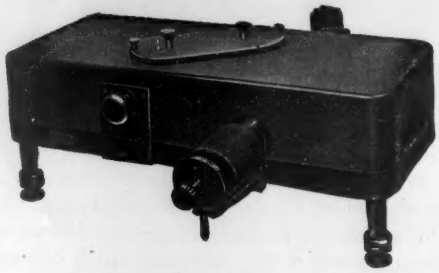

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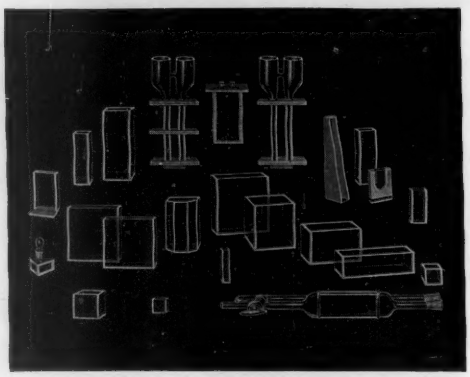

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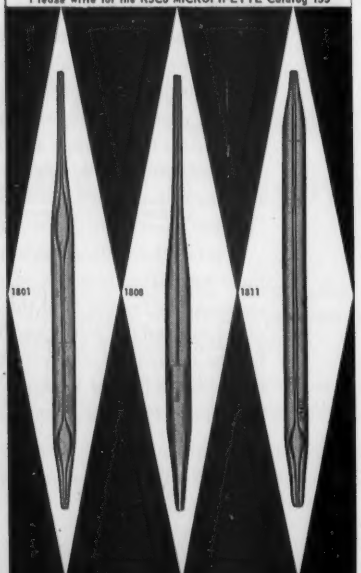

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Medical Research in Perspective

James A. Shannon and Charles V. Kidd

The years since World War II have witnessed a many-faceted revolution in medical research in this country. Perhaps the most significant aspects of this revolution relate to the substance of medical science itself, to such things as the unprecedented and enormously fruitful adaptation of the techniques of the physical sciences to biology and medicine. There have been, however, equally interesting developments relating to the means by which scientific ends have been achieved. Some of these developments, which have a profound but often unrecognized impact on progress in research, are the subject of this article. We wish to discuss changes in the volume and source of funds for medical research and some of the implications of these changes. Then, in particular, we discuss the manner in which support of research by the U.S. Public Health Service through the National Institutes of Health affects institutions and individuals.

Volume and Sources of Support

The dollar volume of support for medical research in this country has increased from some $40 million to some $240 million over the past 15 years (Fig. 1). This is rapid growth, but two pertinent facts should be borne in mind in considering the rate of increase. First, it has simply paralleled the increase for all research and development in the United States over the same period, continuing to represent roughly 5 percent of that total. Second, taking into account the decline in the value of the dollar, the $240 million represents only about $120 million in 1940 dollars, or a threefold expansion of effort as measured in dollars of constant purchasing power.

In all probability, these data understate the increase in support for medical research during this period. There are no fully reliable estimates of expenditures for medical research for the years before World War II, but the estimate of 1940 expenditures is probably somewhat high.

Accompanying this marked change in the total dollar support of medical research are changes in the origin of the dollars (Fig. 2). In the immediate prewar period, 1940, the federal contribution to the national support of medical research was some $3 million, representing 7 percent of the total. By 1944, in the latter part of the war, expenditures for research and development for the conduct of target research by the Armed Forces and by the Office of Scientific Research and Development increased the federal expenditures to $10 million, representing about 16 percent of the total. The year 1947 may be considered the first year of the postwar era in medical research. Support by the Federal Government expanded markedly to a level of $28 million in absolute terms. In addition, the proportion of all expenditures represented by federal funds was 32 percent, twice the 1944 proportion. By 1955 the total support of medical research had risen to $240 million, with the Federal Government's share being $113 million, or more than 40 percent.

During the years since World War II, the large volunteer health agencies have greatly expanded their support of medical research, while the relative—but not the absolute—contribution of the older endowed foundations has declined. It is very significant that the increases in Government support have not reduced the contributions from philanthropy, endowment, or private industry. In fact, private support for medical research has increased in the postwar period, although not in proportion to the expansion of federal aid.

Sites of Research

Not only the source and volume of support for the national medical research effort, but the location of the research is important. Somewhat more than $40 out of every $100 for medical research is expended in medical schools and universities. In absolute terms, these institutions spent about $100 million in 1955 for medical research (Fig. 3). Roughly $75 million of this total was spent in medical schools.

One of the most significant aspects of the financing of medical research in academic environments is the diversity of sources of support. Less than $20 million of the total of about $100 million expended in these institutions came from endowment, or "hard money." About $30 million came from all kinds of philanthropy—individuals' gifts, private health associations, and foundations. The contribution directly from industry was small, but the indirect industrial contributions (typified by such groups as the industry-supported Life Insurance Medical Research Fund) counted as philanthropy were substantially larger. Finally, the Federal Government provided $55 million to these laboratories in 1955. It is abundantly evident from these figures that academic research is largely dependent on sources of support which are not controlled by the institutions themselves. It seems quite probable that endowment income will not rise to a level that will change this situation in the foreseeable future. Moreover, one may question whether support from private philanthropy will rise markedly. Hence, there is a high probability that the two major sources of expanded support for medical research in the future will be corporate giving and federal funds.

In addition to the medical research

Dr. Shannon is director of the National Institutes of Health, U.S. Public Health Service. Mr. Kidd is chief of the Office of Research Planning, National Institutes of Health. This article is based on a paper presented at the annual meeting of the Division of Medical Sciences, National Research Council, Washington, D.C., May 1956.

conducted in private, nonprofit institutions, medical research conducted by pharmaceutical firms and other industrial concerns approximated $80 million in 1955. Much of this work relates to process research, product development, and associated lines of investigation, but substantial sums are spent for more general studies.

Finally, the medical research laboratories of the Federal Government had current operating budgets of about $58 million in 1955.

In view of the national significance of federal expenditures for medical research, these funds and the policies that govern their distribution deserve careful attention.

Federal Expenditures for Medical Research

The total federal expenditure of $113 million for medical research in 1955 was made through five administrative agencies—the Department of Health, Education, and Welfare ($64 million); Department of Defense ($31 million); Atomic Energy Commission ($11 million); Veterans Administration ($6 million); and National Science Foundation ($1 million) (Fig. 4).

One might question—and many have—whether support of medical research by five different federal agencies is a sound way to conduct the affairs of government. The obvious objections to such a system are that duplication of administrative effort may be involved, that lack of coordination is possible, and that duplication and overlapping of research support can occur. In practice, these have remained potentialities. On the other hand, in research, as contrasted with most other activities of the Federal Government, a positive and fundamental advantage arises from performance of roughly the same function by several agencies. Diversity of sources of federal support is important because the most significant decisions relating to support of medical research are matters of judgment. When scientific judgments are involved, the total research program of the nation is best served if decisions are not centralized but dispersed so that various advisers, various points of view, and various interests can be brought to bear on complex problems. And from the standpoint of those whose research is supported by federal funds, there are dangers in having all the "eggs in one basket." Neatness, symmetry and simplicity, which might appear in the organizational chart if a single agency were responsible for research support by the Federal Government, would not contribute to the essential efficiency and productivity of the federal effort.

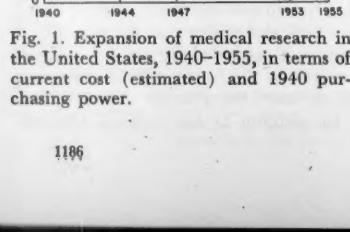

Fig. 1. Expansion of medical research in the United States, 1940–1955, in terms of current cost (estimated) and 1940 purchasing power.

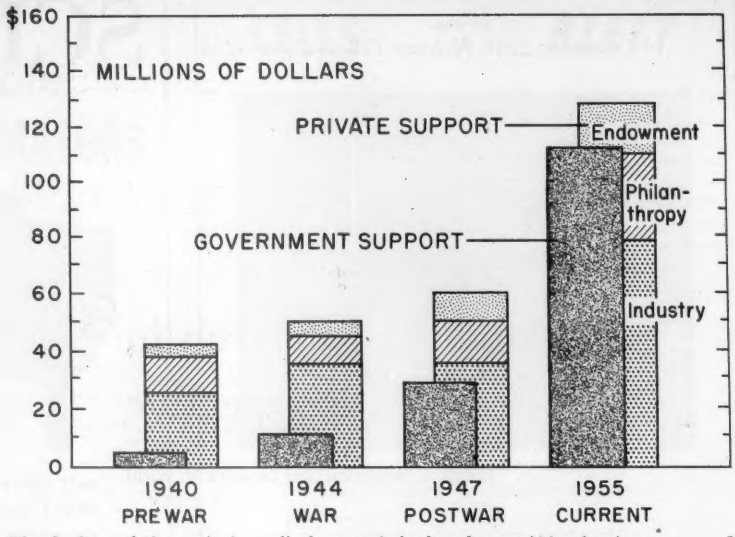

Fig. 2. Cost of the nation's medical research in four key periods, showing sources of support.

The amount of federal funds for medical research is now so large that not only the volume of funds but the terms and conditions for receipt of funds are matters of high significance to the total medical research program of this country. Just why this is true can be seen by looking in some detail at the questions of policy that have arisen in connection with the research grants and training awards administered by the National Institutes of Health.

Budget of the National Institutes of Health

Take first the magnitude of the budget of the National Institutes of Health. Figure 5 represents the development of the program over a 10-year period, broken down into (i) direct operations and (ii) research grants and training. For the year that ended 30 June 1956, the total budget of the National Institutes of Health was $98 million (Fig. 6). Of this, approximately $30 million was expended for the operation of the NIH laboratories in Bethesda, Maryland, and elsewhere. The great bulk of the remaining $68 million was distributed to medical schools, universities, hospitals, and other nonprofit research institutions.

For the year beginning 1 July 1956 (federal fiscal year 1957), the appropriation for NIH will total $183 million. The direct research funds will rise from the $30 million of the preceding year to $37 million. This increase will be used almost entirely to complete the execution of a 10-year plan for full utilization of the Clinical Center, a large new building for laboratory-clinical investigation.

The funds for research grants, for training, and for some relatively small related programs will be at a level of $146 million, an increase of $78 million over the previous year. It is worth noting that of the total increase of $85 million, $78 million is for grants and awards as compared with $7 million for the direct federal operation.

The large increase in grant funds is, in effect, a statement of national policy by Congress that lack of funds should not impede medical research in this country. The appropriation, however, is viewed not as a blank check to be used as a subsidy for any research or training proposals that may be made. Rather, it is viewed as an unparalleled opportunity to move the medical and biological aspects of research in this country ahead as rapidly and as productively as possible,

with maximum utilization of existing facilities and of the present supply of qualified investigators, and with particular attention to strengthening the research potential in years to come. In some fields, the funds provided by Congress will undoubtedly prove to be more than can be effectively expended. In this connection, discussions with the numerous scientific advisers to the various institutes have revealed a spontaneous consensus to the effect that the standards of eligibility for receipt of any grants from NIH should not be relaxed in any way.

Viewed in this light, the 1957 appropriation for NIH does not modify the basic objectives of the programs—the support of medical research and training for research throughout the country—nor does it solve continuing policy questions involved in the administration of these Public Health Service programs.

Categorical Approach

Research grants from the NIH are distributed through a series of institutes that bear the names of categories of disease—cancer, heart disease, and so on (Fig. 7). Support of research through an organization based on categories of disease has certain inherent potential problems, such as the obvious one that orientation toward certain diseases will lead to pressure for quick production of applicable findings, thereby sacrificing basic research.

A primary aim of the NIH is to administer the programs in a way that prevents the potential hazards of the disease-category system from becoming real.

It should be noted that there is nothing in the disease-category approach to medical research that is inherently less desirable than, say, an approach based on organization according to scientific disciplines, or one based on body organs or systems. What is required is that any system of categories include the total range of relevant inquiry and that relevance be intelligently defined. This is the case with respect to the totality of the disease categories that describe the missions of the seven institutes comprising the NIH. It is certainly true that any system of fragmenting knowledge in order to organize thought and work can lead to isolation of areas of thought and to sterility of thought within the confines of a narrow category. In any case, common usage rather than logic confines the meaning of categorical research in medicine to the category defined in terms of groups of diseases. Support of research in categories defined as scientific disciplines would represent the same potential danger to the prosecution of fully effective research as does the defining of categories by disease. This point was epitomized by Detlev W. Bronk when he said, "Why is it that a person who studies the heart action of a frog is a zoologist while one who studies the heart action of man is a physiologist?"

Moreover, the potential relevance of research to any disease category is defined in terms of long-range possibilities and not in terms of work directed toward the quick solution of problems obviously and solely related to a given disease. These two factors taken together permit support of research of the type that the scientific world takes for granted as the essential prerequisite to large forward advances against specific diseases. It is significant that this view is shared and formally stated by Congress. For example, in June of this year the Senate Appropriations Committee submitted a report to the Senate containing these words: "The Committee reiterates the fact, expressed in its reports of earlier years, that it positively encourages the use of cancer research funds, and funds of other Institutes, for fundamental studies—such as steroid chemistry and cell physiology—which must underlie clinical and laboratory investigations directly related to specific diseases" (*1*).

Investigators throughout the country are for the most part, but not entirely, convinced that they need not "angle" what they wish to do in order to increase the probability of receiving a research grant from the NIH.

Ultimately, the disease-category structure for research support by the NIH is a consequence of the interests and desires of the American people, reflected in the actions of Congress. Increased popular support of medical research is predicated on public confidence that research will yield answers to problems of disease.

The goal sought is not a scientific but a moral one. Congress, on the national scene, interprets the moral end in the political terms required if the urge to help relieve pain and prevent death is to be more than an aspiration. This interpretation, which is in effect the construction of a bridge between widely shared humanitarian goals and the world of research within which these goals are sought, relies upon disease categories. People understand disease, and research can be productively segmented by disease category with the application of intelligence, common sense, and due concern for the essential unity and increasing interdependence of the scientific disciplines.

Project System of Support

The NIH programs are characterized not only by a disease category form of organization, but by a project system of support. The research-project approach can be pernicious if it is administered so that it produces certain specific end products, or if it provides short periods of support without assuring continuity, or if it applies overt or indirect pressure on the investigator to shift his interests to narrowly defined work set by the source of money, or if it imposes financial and scientific accounting in unreasonable detail.

After 10 years of experience in the administration of a system using the word "project" for the applications sub-

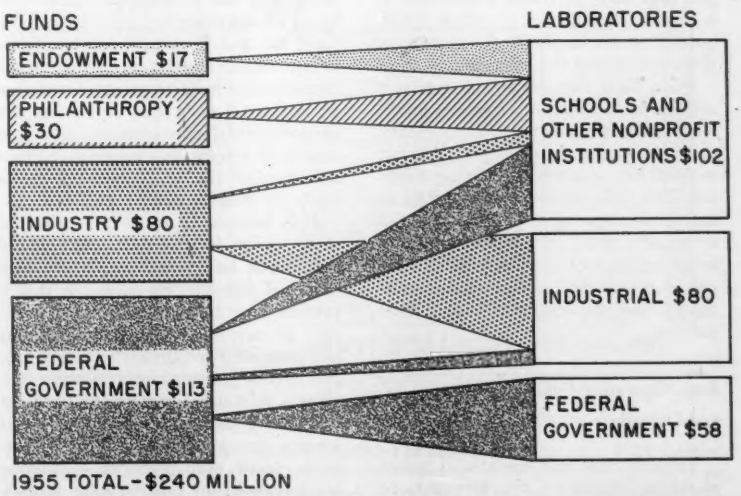

Fig. 3. Cost of the nation's medical research in 1955, showing sources of funds and their distribution.

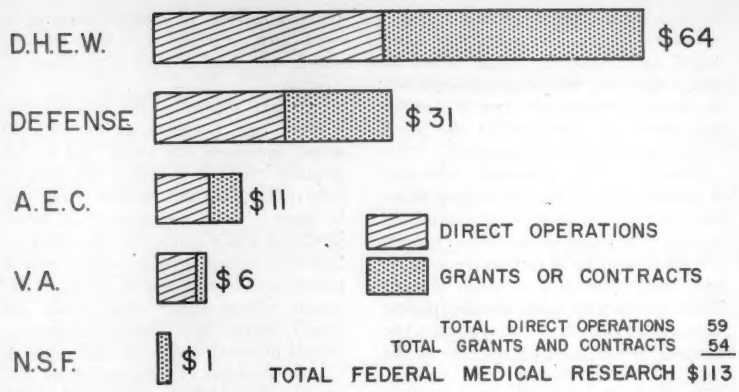

Fig. 4. Total federal expenditure (millions of dollars) for medical research in 1955, by agency and type of program.

mitted by investigators, it appears that the evils noted in the previous paragraph can be and have been averted, primarily by attention to procedures centering around extension of the freedom of the investigator.

Freedom is extended by quite specific principles, devices, and actions—for example, by providing more funds for broadly defined areas of study and more support for research that is not directly related to a specific disease; by increasingly stable support; by freedom to change lines of inquiry; by freedom to shift the uses of budgeted funds; and by freedom from detailed reporting requirements.

The degree to which such basic objectives are attained is an important criterion used by the NIH and its advisers in assessing the quality of administration of the program of research grants. The fact that, by statute, support can be provided only for research described as a project is a matter of minor consequence as compared with the more basic characteristics of the program.

Thus, both the categorical approach and the project system are viewed by the NIH and its advisers not as fundamental characteristics of the grant programs but as relatively superficial operating methods. The fundamental matters relate to the specific operating policies designed to support good people, to sustain a broad concept of relevance to disease, and to extend the freedom of the investigator. We now turn to some of these policies.

Basic Operating Policies and Objectives

There is, first, the operational policy of relying heavily on scientific advisers, grouped together as "study sections," to provide advice both on the capabilities of the person or persons and on the quality of the research proposal. The judgments and actions of the study sections are reviewed by other advisory groups, the National Advisory Councils, which consist of representatives of the public at large as well as scientists, and which make final recommendations to the Surgeon General. This reliance on rotating groups of technically qualified advisers is, essentially, a means of securing a sound consensus of peers. The advisory system provides a bulwark against arbitrary, uninformed judgment, and is, in this sense, a device for extending the effective freedom of all investigators as a group.

A second policy objective is extension of stability of support for investigators. Assured continuity of financial support is, in the final analysis, directed toward extension of the freedom of the investigator. It permits continuity of effort and thought of the investigator, undisturbed by an annual personal fund-raising drive. Over the past 5 years, it has been possible to extend from 20 to 50 percent the proportion of research grants that receive support for 3 to 5 years and to cut the proportion of 1-year grants from 50 percent to 10 percent. It is hoped to increase still further the proportion of grants made for these longer periods.

It is relevant to ask why a principle of operation which is obviously sound should not be applied even more rapidly and widely. The answer is that a balance must be sustained between support of new and younger investigators and those who are already receiving support. When grants of long duration consume a substantial part of any fund for research support, the amount available for new grants in any given year is relatively small even with an expanding budget. As in the case of many aspects of administration of research grants, the problem is not how to attain a single clearly defined objective but how to compromise between equally sound and sometimes mutually exclusive goals.

A third general objective for the research-grant program is to increase the average amount of the individual grants in order to provide funds in amounts sufficient to permit broader leeway to responsible investigators.

Over the period 1951–1955, the average (mean) new grant increased only from $10,300 to $10,800. The median grant in 1951 was $7600, and in 1955 it was $8400. When one considers that prices rose by about 10 percent over this period, the real value of the average new grant in 1955 was quite close to the real value of the average in 1951. On the other hand, it is worth noting that, in 1955, 37 new grants were awarded for annual amounts in excess of $30,000. The average amount of these grants was $47,000. One dollar in every six for new grants was for a grant in excess of $30,000 a year; and these grants totaled $1.7 million a year. Serious discussions with the study sections and the national councils that advise the National Institutes of Health have shown a unanimous desire on the part of members to see the broad research programs of additional numbers of thoroughly competent and prudent investigators supported through grants of substantial proportions for relatively longer periods of time, and to provide for investigations that may be described in terms of general rather than limited areas of interest. This is a major means of extending the freedom of mature investigators under a program of research grants, and there will be steady movement in this direction.

There are, incidentally, substantial advantages to the investigator in receiving funds in large segments from one or two sources rather than small segments from a large number of sources. The primary advantage is that differing sources of funds have different reporting require-

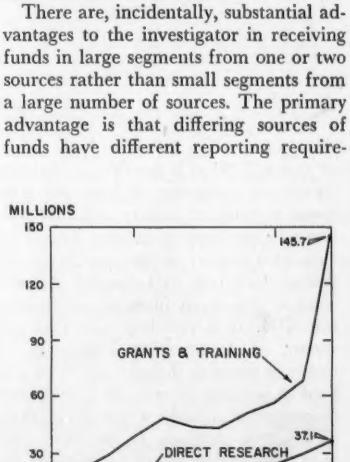

Fig 5. Annual appropriations to the National Institutes of Health, 1947–1957, by type of program.

ments, accounting requirements, and the like. The more numerous the sources of funds, the more time must be spent in writing reports and in performing nonproductive chores of various kinds. For this reason, it may well be that diversity of sources of support for medical research, which is widely accepted as a desirable national objective, should not be attained primarily through the support of single investigators by a large number of grants and contracts. The limits of such a course of action will be set by two factors—the total volume of funds available, and the desire of investigators to seek support from a single rather than a multiple source.

A fourth policy area relating to freedom of the investigator is the frequency and detail in which the investigator must report changes in the substance of his investigations, changes in the use of granted funds, and the progress of his work. Investigators who receive grants from the NIH file general reports at widely spaced intervals and report the substance of their work in the professional journals. Precise reporting to the NIH of scientific findings in the form of "progress reports" would serve little purpose, and publication in the journals seems preferable.

Investigators can and do, without asking permission, shift the emphasis of their studies in response to new leads that may develop.

Two procedural changes having to do with the handling of funds illustrate a general point with respect to the administration of research grants. First, investigators who receive grants for more than 1 year may carry over unexpended balances until the end of the recommended period of support. This replaces the earlier rule under which balances unexpended in any year would be returned to the Government. The new procedure produces additional flexibility and should result in more effective use of granted funds. The second change relates to freedom to shift grant funds among various kinds of expenditures—salaries, supplies, and so forth. Expenditures may now be made for the most part at the discretion of the grantee without checking with the NIH institutes. For example, if work evolves in a way requiring a major shift in expenditure to permit the employment of additional people, the change may be made without requesting permission. The reduction in paper work and the increase in flexibility is apparent. Some limitations, however, are placed on shifts in expenditures from the pattern stated in the grant application. Grantees may take foreign trips not provided for initially in the grant budget only after securing permission from the advisory body. Moreover, funds for direct research may not be shifted to indirect costs such as overhead.

These changes are important not only insofar as they are sound, but also because they illustrate the manner in which policy actually evolves. Rarely is a radical shift made from one way of doing business to another. Policy is the cumulative result of a series of related steps, no one of which may be particularly significant in itself. Rules are adjusted and modified with general objectives in mind —in this case, those which assure the greatest practical freedom for the investigator commensurate with the public interest.

Problem of Balance

One of the most intricate and elusive problems facing those who administer public and private plans for the support of medical research is how to attain and maintain an appropriate balance among three interdependent elements of a broadly conceived program: (i) current research support, (ii) training of manpower, and (iii) provision of adequate research facilities. The funds that are provided through the NIH are such a significant portion of the nation's total medical research effort that these interrelations must be a matter of concern. Reducing this abstract statement to the realities of the present scene, it appears quite clear that the attainment of sound balance among the three elements of research support call at this time for increased emphasis on training of manpower and on expansion of research facilities.

Here again it should be stressed that Congress is aware of the shortages of well-trained investigators and of laboratory space. The report that was submitted this year to the House of Representatives by the Appropriation Committee stated: "The Committee calls particular attention to the urgency of taking steps at this time to ensure that an adequate supply of medical research scientists will be available in the years ahead. No aspect of the Federal program for support of medical research is more significant than manpower training" (*2*).

As is true of research grants, funds for training will be markedly expanded in the year that began 1 July 1956. The appropriation for research fellowships and training grants totals $33.5 million, as ompared with $17.3 million in the preceding year. This volume of funds will support a substantial expansion of training activities and at the same time will highlight certain fundamental problems of education. These relate to the size of the total annua1 pool of physicians and basically trained scientists from whom the nation's supply of medical investigators is drawn, to the complex set of difficulties involved in the quality of science teaching at all levels, and to deeply imbedded cultural values that are not most conducive to the maturing of scientific talent.

While NIH has no direct and formal responsibility for these broader aspects of science in American life, it does have

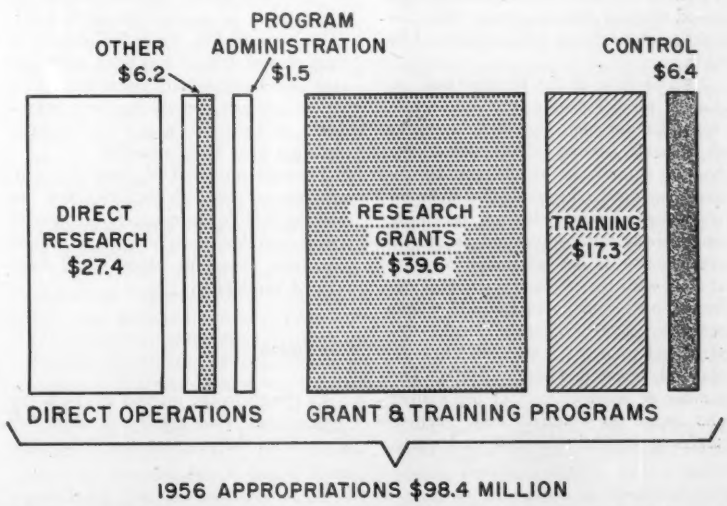

Fig. 6. Appropriation to the National Institutes of Health for fiscal year 1956, by type of program. The category *Other* includes the following: professional and technical assistance, $3.5 million; review and approval of grants, $1.3 million; biologics standards, $1.3 million; and dental resources, $0.1 million. The Control funds were transferred to the Bureau of State Services for grants to states.

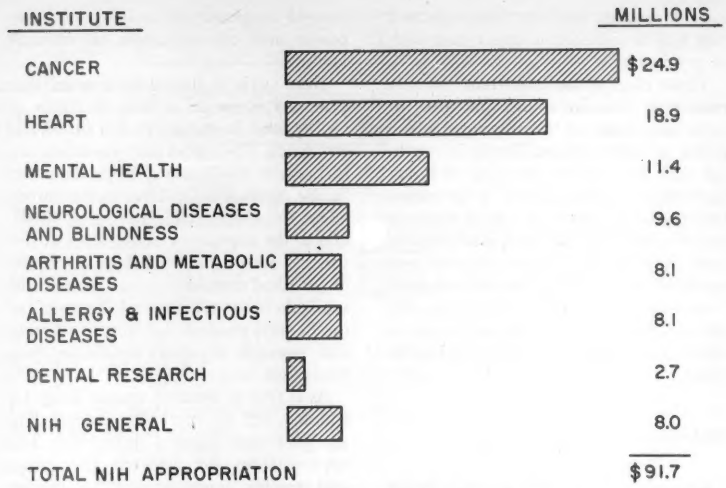

Fig. 7. Appropriations to the National Institutes of Health for the research-grant programs, fiscal year 1957, by categorical institute.

a clear obligation to sense emerging needs in the area of advanced training in biology and medicine and to adjust the nature of training programs to meet these needs. With extensive advice from the academic world, two specific problems have been identified as particularly significant.

1) There are well-recognized deficiencies in the training of physicians for careers in research. Rarely does a physician receive the rigorous training in research methodology that is typical of the Ph.D.-type of training. Experiments devised by medical schools and designed to remedy this weakness for students who intend to enter research rather than the practice of medicine will be financed by NIH.

2) The state of the sciences basic to clinical medicine—the preclinical sciences—has for some time been a matter of concern among those who have thought extensively about medical research, medical education, and their interrelations. These fields are becoming progressively more important as the essential unity of biological and medical sciences with the physical sciences is expressed operationally in the design and execution of experiments. Despite unparalleled need for a vigorous effort in this field, research is not flourishing. The number of younger men of top caliber who aspire to research and teaching careers in medical schools is inadequate. As one means of improving this situation, NIH is offering senior research fellowships with sizable stipends for 5-year periods. These are awarded to relatively mature investigators as a means of attracting persons to and keeping them in the preclinical sciences. Senior research fellowships totaling $500,000 will be awarded this year, and the program will be expanded to a level of $2.5 million in $500,000 annual increments.

In connection with the need for more adequate laboratory space, legislation that authorizes the appropriation of $90 million to the Public Health Service over a 3-year period for assistance in the construction of medical research facilities was enacted by the 84th Congress. A total of $30 million has been appropriated under this bill for fiscal year 1957, a new advisory council has been established, and the first grants on a matching basis have been awarded.

Through provision of funds for construction of research facilities and for training additional research manpower, a situation has been averted in which expansion of grants alone could have created imbalance.

Conclusion

To return to the mission of NIH, the "extramural" program is now quite different from the program of 10 years ago. The word *project* has been defined and interpreted to provide greater flexibility; the volume of paper work has been significantly reduced. The duration of support has been increased, and there has been a broad geographic spread as more and more institutions have developed research interests and capabilities. The training program has been broadened in many ways to meet both general and quite specific needs.

The major point to be made here is not the substance of these changes but the fact that the research grant and training programs have changed, are changing, and will change in the future. Productive science is dynamic, just as a productive society and economy are dynamic. A federal program operating in such a complex, shifting environment must change if it is to serve most effectively. Responsible and responsive administrators of federal research programs have a very real and significant obligation to act so that federal activities increase the productivity of research and the vitality of training. There is a clear obligation to serve as the instrument through which these means are met through change.

It seems virtually predictable that the relationship between medical research and medical education will be an area of utmost importance and one in which significant changes will be made progressively over the years.

If the changes are to be wisely conceived and executed, administrators must act on the basis of sound, widely representative advice. Never in the history of medical science and medical education has it been so important that close, sympathetic understanding be sustained between private research groups, universities and medical schools, industrial research groups, and federal agencies. The extension of federal aid to medical research and related training over the past decade has created an unprecedented situation, one in which the actions taken federally are of such significance that wide participation in the decision-making process is essential.

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Centenary of J. J. Thomson

George Thomson

When Joseph John Thomson was born on 18 December 1856 in a Manchester suburb, physics was curiously different from what it now is. This is not merely a statement of the obvious fact that in the intervening century so much has been discovered to which he and his pupils contributed a substantial share but of a difference in outlook. In those days physics was taught as a branch of mathematics. The first teaching laboratory in England, the Clarendon at Oxford, was not started till 10 years later. Certain university professors did indeed do experimental research, notably Sir William Thomson, afterward Lord Kelvin (no relation to J. J.), at Glasgow and Stokes at Cambridge, but even in Scotland, which was in this respect more advanced than England, practical work was limited to lecture experiments. Faraday was still working in London at the Royal Institution in the laboratory that had been founded 50 years before by the expatriate American Count Rumford, and Henry was in Washington at the Smithsonian Institution.

"J. J." was of the first generation to be taught physics as a practical subject. He entered the newly founded Owen's College, now the University of Manchester, at the early age of 14 and took a course of engineering for 3 years, changing then to physics and mathematics, because his father had died and his mother could not afford the heavy premium that an apprentice engineer was then expected to pay. But he did not remain long at physics; after 2 years he went up to Cambridge with a scholarship and read mathematics, as was then the custom. Although, after taking his degree, he started some experimental research in the Cavendish Laboratory where Lord Rayleigh had just succeeded Maxwell, it was his mathematical work that first brought him reputation, and he continued to produce mathematical and experimental work concurrently throughout his long life. I have heard him say that mathematical research was more enjoyable than experimental. With an experiment, one spent a lot of rather worrying effort overcoming a series of practical difficulties to get the thing to work; when it did work, one took a few readings and all was over.

Sir George Thomson, son of J. J. Thomson, is master of Corpus Christi College, Cambridge, England.

Theoretical Work

In those days Maxwell's theory was new, and most physicists found it very difficult, especially the idea of electric displacement, which it must be admitted was not made very clear. J. J. set to work to be the interpreter of Maxwell, and it is characteristic that he did so largely by introducing a more picturesque physical conception than that of Maxwell, developing Faraday's idea of tubes of force. However, this came a little later. In his first paper (1881) he used the technique of Maxwell to derive the field around a moving charge. This paper contains, I believe, the first hint of a connection between energy and mass. It showed that an electrified sphere would have its effective mass increased by the mere fact of electrification. He also found an expression for the force on the moving charge in the presence of a magnetic field, a result which some 10 years later, with a different numerical constant, came to figure as the "Lorentz term." Incidentally, he also found the value for the magnetic field due to the moving charge.

At the same time that he did his electromagnetic work, he also produced for his fellowship thesis at Trinity College a treatment of thermodynamics by the method of Lagrange equations, and a little later he won the Adams prize with a long essay on vortex motion, which interested him because of its possible connection with atomic theory, since the intricacies of vortices had appealed to both Kelvin and Helmholtz as possible models for the atoms of chemistry. It is odd that this long-obsolete theory should in fact have led J. J. to his first work on electric discharge. It seemed to him that the theory might indicate that chemical dissociation would be necessarily associated with electric charge and that the conductivity of gases was an example of this. His first experimental paper in the new field was published with Threlfall in 1886, and for the rest of his life he was seldom without an experiment on the conductivity of gases or the phenomena shown by the discharge of electricity in them. For some years these experiments did not lead to anything of prime importance, and before reviewing the great events associated with the discovery of the electron one may follow through with the development of his theoretical work. At the end of 1884 he succeeded Rayleigh as Cavendish professor at Cambridge.

In 1891 he published a paper in which for the first time the idea of momentum in electromagnetic radiation was put forward and given a mathematical expression. Thomson showed that it was in the direction of the vector which Poynting had established a few years before.

Two results that he found after the discovery of the electron belong more properly here. In his Silliman lectures at Yale in 1903, he carried the idea of the connection between mass and energy a bit further forward and showed that the electrostatic energy in a unit volume was equal to the kinetic energy of the mass which (so he calculated) was bound by the tubes of force, moving with the velocity of light. This was one stage further toward the relationship $E = mc^2$ which was formulated by Einstein in 1905. In the same set of lectures, he put forward the view that the wavefront of light is not uniform but consists of specks of great intensity separated by considerable intervals where the intensity is very small. His evidence for this was the strange behavior of x-rays in ionizing the gas through which they passed, although the absorption in the gas could be small. Certain molecules of the gas were, so it seemed, picked out for special treatment. This is, of course, one example of the photoelectric paradox that caused so much trouble in the 1920's, and which was formulated, rather than explained, by Einstein's postulate made in 1905 that the energy of radiation proceeds in quanta of magnitude $h\nu$.

The Electron

Let us now turn back to his work on the electron, by which he is best known to the present generation. There were two quite different lines of approach that led at the end of the 19th century to the discovery of what we now call the electron—the need in electrical theory for charge to be regarded as being done up in separate bundles, multiples of a unit rather than continuous, and the discovery of elementary particles carrying a charge.

The first evidence for a unit charge comes from Faraday's experiments on electrolysis, and it is curious that these experiments were not taken more seriously at the time that they were made as proving that electricity is made up of units. Some of the earlier theories of electricity, such as that of Weber, did indeed treat electricity as existing in separate charges, but the magnitude of the charge did not come directly into the theory or play any very important part in it. Johnstone Stoney in 1874 had called attention to the importance of the charge carried on a monovalent atom, and in 1881 he estimated its value at 3×10^{-11} electrostatic units (the true value is 4.8×10^{-10} electrostatic units). The name *electron* is also due to Johnstone Stoney, although it does not seem to occur before 1891.

In one sense the electron was named before it was discovered. Maxwell's theory has nothing to say about electrons, but the development of it, which Lorentz made early in the 1890's, required the conception of discrete charges. This theory found its first experimental support in 1896, when Zeeman discovered the effect that goes by his name. Zeeman was a pupil of Lorentz, and Lorentz at once put forward an explanation of the results in the form which is familiar to most. In Zeeman's early experiment the magnetic field was not strong enough to resolve the lines, fortunately for him, for the cases he examined showed the "anomalous" effect, but he made an estimate of e/m, the ratio of the charge to the mass of the "electrons" responsible, which he found to be of the order 10^7, 1000 times that for the hydrogen ion. Curiously enough, in his first paper he gives the sign of the charge as positive instead of negative. It is a matter of interest that the last experiment of Faraday's life was an unsuccessful attempt to detect precisely this effect, and it was as a result of reading about this experiment, in a sketch of Faraday's life written by Maxwell, that Zeeman was led to try the experiment again with more modern equipment.

The other line of attack is a quite different one. It comes from experiments on the electric discharge which go back to the middle of the 19th century, when cathode rays were discovered by Plücker, but here also the year 1896 is critical. In November 1895 Roentgen discovered x-rays. This apparently almost accidental discovery has perhaps had more direct effect on physics than any since that of Galvani. J. J. was one of several who discovered almost simultaneously early in 1896 the ionization produced by x-rays, and Rutherford (who had just come to Cambridge as a young research student from New Zealand) joined him in working on it.

Now cathode rays had been a source of great interest to physicists for a long time, and there was a controversy about their nature in which physicists were divided on roughly national lines. Germany favored the view that they were some form of electromagnetic radiation, while France and Britain believed that they were corpuscular. The strongest evidence for the theory that they were electromagnetic radiation was the discovery by Lenard that the rays could be sent through a thin sheet of metal into the atmosphere, and to do so must have penetrated through many atoms without losing their original direction. This seems familiar enough to us, but to the physicists of those days it seemed impossible that anything material, even the hydrogen atom, could be small enough to do this. The strongest evidence for their being corpuscular was their deflection in a magnetic field. Perrin had shown that when a collector was placed opposite the rays it received a negative charge, and that when the rays were deflected away by a magnetic field the charge ceased. J. J. showed that the charge followed around with the rays when these were deflected, and so was very closely associated with them. There was, however, a serious difficulty. Hertz had shown that they were not deflected by an electric field, as moving charged particles surely must be.

In April 1897 J. J. gave a lecture at the Royal Institution in which he described how he had determined the ratio e/m for the cathode rays. This was done by measuring with a thermopile the heat conveyed by the rays and also by determining their charge and their deflection by a magnetic field. A little earlier, in February, J. J. had shown that the deflection of the cathode rays in a magnetic field was independent of the gas, provided that the voltage on the tube was kept the same. He now showed that the value of e/m was of the order of 1000 times greater than that for hydrogen in electrolysis, and, further and more important, that it was the same for air, hydrogen, and carbon dioxide in the tube, and whether the electrodes were iron, aluminum, or platinum. In this lecture, and in the more detailed paper published in October of the same year, J. J. stressed the universal character of the cathode rays and gave reasons for supposing that they were universal constituents of matter. In the latter paper, he described his well-known method by which e/m is determined by comparing electric and magnetic deflections and measuring the latter. His e/m tube is the direct ancestor of all cathode-ray oscillographs. But Hertz had shown that the rays were not deflected by an electric field. The explanation is quite simple, once you know it. In the tubes used by Hertz there was a considerable pressure of gas, and as this became ionized the ions moved up to the plates between which the electric field was supposed to have been generated and to a large extent neutralized it. J. J. was able to show that if the pressure was sufficiently reduced (a matter of considerable labor in those days), an electrostatic deflection of the rays gradually appeared.

In discussing his results, J. J. rejected the idea that in some way the mass of the electron represented an electromagnetic contribution to the mass of atoms, which, it might be vaguely conjectured, could have been shaken off the atoms by the rapid motion. He preferred instead Prout's hypothesis brought up to date and supposed that all atoms were made from common constituents. He was partly influenced in his view by Lenard's experiments showing that the cathode rays were absorbed by matter roughly in proportion to the mass penetrated, which was to be expected if their absorption was due to collision with a constituent present in all matter in proportion to the density. Lenard's experiments also convinced him that their mass was very small. In this same paper he put forward a model atom based partly on the American physicist Mayer's experiments with floating magnets controlled by a strong central magnetic pole.

These were not the only measurements of e/m made about this time. Kauffmann in July of the same year published a value based on the assumption that the energy acquired by the cathode ray was equal to that acquired by a charged particle falling through the potential difference of the tube. This involved the assumption that no appreciable amount of energy was lost to the gas, an assumption at the time not fully justified. Indeed, not many years before, Schuster had used the same principle to give an upper limit but had contented himself when he calculated that a *lower* limit, which was obtained by assuming that the velocity of the particles was the same as that of the mean square of the atoms of the gas in the tube, gave a result that was compatible with the rays' themselves being atoms.

Wiechert early in the year had published in the rather obscure journal of the Königsberg Scientific and Economic Society a rather similar investigation. He rightly regarded Kauffmann's assumption as giving an upper limit to e/m, which he found to be 4000 times greater than for hydrogen in electrolysis. He supposed—it is not quite clear why—that the cathode fall of potential gave a lower limit to the energy, in his case leading to a value 400 times that for hydrogen. He then developed a method invented the year before by Des Coudres which was theoretically sound; it in-

volved measuring the velocity of the cathode ray against the oscillations of an electric system of the Hertz kind. He was just able to show first that e/m was more than 200 times that of hydrogen and then that it was more than 2000 times, with an indication that this was not far from the true value. This early work was not exactly a measurement, but it certainly indicated that e/m was much larger than it was for hydrogen. Wiechert assumed without proof that e is the same for cathode rays as for hydrogen and explicitly stated that cathode rays were not ordinary atoms. He did not apparently consider them universal constituents of matter but rather as "atoms of electricity."

Although the value of e/m was 1000 times larger than that for a hydrogen atom, this was not direct proof that the difference was due to small mass. It might conceivably, though improbably, have been due to a much larger charge. Improbably, because it was unlikely that this large charge would be the same for different gases and for various electrodes, as J. J. had shown it to be. Lorentz, in commenting on Zeeman's discovery in 1896, had suggested that the electric atoms concerned in it had mass of about 1/1000 of that of the hydrogen atom. However, measurements of the charge on various ions were being made. Townsend in the Cavendish Laboratory had measured the charge on some gaseous ions evolved during electrolysis, probably as a result of splashing. He got a value near that then assumed for the charge on a monovalent atom in electrolysis but found that the charge on hydrogen was from one-third to two-thirds that on oxygen. Later in 1898, J. J. measured the charge on the ions that he and Rutherford had shown were produced by x-rays in gases. He used a method based on C. T. R. Wilson's work on clouds. Drops were produced by expansion, their size was determined from their rate of fall, and their number was determined from the size and the mass of water available to be deposited. Then e came from knowing the saturation current produced in the gas by the x-rays. The original value was 6.7×10^{-10} electrostatic units, but it was corrected 3 years later in a second experiment to 3.2×10^{-10}, because it was thought that in the first experiments the negative ions had a tendency to monopolize the vapor and that the whole of the positive ions had not been brought down.

Although it was interesting that this charge was of the order of that expected from the charge on a hydrogen atom in electrolysis, the x-ray ions had no direct connection with the cathode rays or, indeed, with Zeeman's electrons. But in 1899 J. J. made a determination of both e and e/m for the *same* kind of ions—namely, those produced by ultraviolet light. He showed that e/m for these ions was approximately the same as that for the cathode rays and that e was the same as for the ions from x-rays. He also showed in the same paper that the negative particles emitted from a hot wire had approximately the same e/m. This really completed the proof. Opposition to the idea of particles smaller than atoms did indeed continue, but it was merely the spasmodic dying kicks of the older physics, a matter of muscular contraction rather than brain. J. J. preferred to call his particles corpuscles, since, at first at any rate, their identity with the electrons of Lorentz and Zeeman was not proved, but the more specific and vivid name has won. I hope myself that it will continue to be used for the primitive negative particle. I have not that desire for symmetry which would make me feel that because we call one particle a positron we must call another a negatron. One is, after all, much commoner than the other.

The early experiments were rather crude, but values of e/m quickly became accurate. The value of e is more difficult to measure, and it was not till R. A. Millikan improved a method due to H. A. Wilson at the Cavendish Laboratory that a reasonably accurate measurement was arrived at. In fact, at the time of Millikan's work, the most accurate measurements were those made on alpha particles with the assumption that each carried a double charge.

I have mentioned J. J.'s early interest in Mayer's experiments. He continued to take this as his model of an atom, except that he replaced the central magnetic pole of the analogy by a uniform distribution of positive electricity throughout the atom. His preference for this model over the perhaps more obvious one (or so it seems now) of planets controlled by a central sun was not merely one of mathematical convenience. He proved that on Newtonian dynamics, and no one had then suggested anything else, such a system of orbits would be unstable if the planets repelled one another, and even if they were not, that they must radiate, by Maxwell's equations, large amounts of energy. The nuclear atom of Rutherford requires the hypothesis of Bohr or something similar to make it tenable, and that, of course, was then a long time in the future.

J. J. spent a good deal of effort on his model. He examined the equilibrium conditions of atoms with large numbers of electrons and showed that an arrangement of rotating concentric rings would be stable and would lead to a qualitative explanation of the periodic table. He also proved that a ring of more than a small number of electrons would radiate extremely slowly when rotating, another reason for preferring his to the planetary model.

Beta rays were quickly shown by Becquerel to be electrons, and the variation of their mass with velocity found by Kauffmann was the first experimental proof of the electromagnetic mass that J. J. had predicted in 1881. Delta rays were the discovery of J. J. (1904), one of his few incursions into radioactivity; they were named by him.

A more far-reaching piece of theory was the attempt to explain conduction in metals by means of electrons. The idea goes back to Weber, but J. J.'s theory, first put forward in 1881 and elaborated in 1900 and 1907 after the experimental work on free electrons, was the first that stressed the exclusive part played by the negative electricity. It regarded the electron as not entirely free, but operating in something of the fashion that the charged atoms in solution did in the Grotthus chain. Here again, of course, was a field where no satisfactory explanation could be produced until the quantum theory had been discovered. J. J.'s reason for retaining from his early theory the rather artificial idea of the Grotthus chain was to avoid the difficulty of the specific heats, which it does up to a point. About the same time O. W. Richardson, working in the Cavendish Laboratory, showed how the thermionic emission of electrons could be explained on a kinetic theory and a formula could be deduced, in part at least, from thermodynamical reasoning.

One of the most interesting questions was the number of electrons in an atom. At first it seemed reasonable to suppose this to be of the order of thousands, the ratio of the masses. Some 10 years after the discovery of free electrons, J. J. published a paper in which by three independent methods he reached the conclusion that the number of corpuscles, as he still called them, in an atom, was not far from the chemical atomic weight. The first method was the dispersion of light in gaseous atoms in which a calculation based on a dispersion formula resembling that of Sellmeier showed that hydrogen has about 1 corpuscle per atom, assuming that it is the corpuscles that move.

The second method is the well-known one based on the formula for the scattering of electromagnetic waves by charged particles, which he had calculated, and the experiments of Barkla on the scattering of x-rays. As we now know, the good result of this method was rather lucky. Long waves will not work because the individual electrons scatter in phase, and for short waves the quantum effects become prominent. However it gave a value for air of about 25 corpuscles per molecule, less than twice too large. The last method was based on the diminu-

tion of velocity of beta rays going through a gas. Attributing this to energy transferred to the corpuscles in individual collisions, he showed from Rutherford's measurements that the number and atomic weight are of the same order. Here there is a logarithmic factor that had to be guessed.

Positive Rays

In 1905 J. J. turned from the study of cathode rays to that of positive rays, in a conscious effort to find the positive constituent of matter. Positive rays had been studied for some time by Wien under their German name *Canalstrahlen*. One may recall that they are formed when a hole is made in the cathode of a discharge tube and then appear as a luminosity in the gas in the region behind the hole. Wien had shown that their e/m was appropriate to that of atoms, but his apparatus did not allow him to resolve the rays coming from different kinds of atoms. J. J. at first thought that he had got a universal constituent, but better experiments and, in particular, the technique that enabled the region beyond the cathode where the rays were observed to be obtained at a much lower pressure than the discharge in which the rays were produced, enabled him to show that the rays depended on the gas in the tube and, in fact, consisted for the most part of charged atoms and molecules of the kinds present in the discharge.

Thomson's was the first mass spectrograph, although he did not use the term. The different atomic species appeared as parabolic arcs on a photographic plate that received the rays. I have vivid recollections of him sitting on a high stool in the laboratory measuring up the last photograph his assistant, Everett, had obtained, the plate clamped in a frame and the arcs measured by means of a needle point carried on two perpendicular slides. The most startling consequence of this work was to come after World War I at the hands of Aston, who had been working as J. J.'s assistant for the 2 or 3 years before 1914.

But there was really more to it than just isotopes. The sharp parabolas were in fact the first real proof that the atoms of ordinary elements are all the same and that atomic weight is an individual property and not merely the mean of a wide statistical variation. Of course, this is true only where isotopes are absent, and, of course, a method that could prove it in certain cases must necessarily discover the isotopes in the others. Actually the situation was a little harder than this would seem to indicate, because the positive rays showed not merely atoms but compounds, and not merely the ordinary valency compounds but almost every kind of fragment of the molecules in the gas; thus water shows OH as well as OH_2, and methane shows all the radicals CH, CH_2, and CH_3.

With the limited pumping facilities of the age, it was very difficult to get rid altogether of the hydrogen that had been absorbed in the electrodes, and, since the accuracy of measurement was only of the order of 1 percent at best, it was not always easy to be sure whether a parabola was due to a new atomic species or to an undiscovered hydride of something else. Hence, when neon was tested and two parabolas turned up with masses of about 20 and 22, it was difficult to be sure whether they represented two species of neon or neon and an unknown hydride, although J. J. inclined strongly to the former view, basing his belief on peculiarities of the parabolas which resembled those of atoms rather than those of molecules. After the war, as is well known, Aston, after an only partially successful attempt to separate the two kinds of neon by diffusion through pipe-clay, made a mass spectrograph of different design and superior resolving power. It enabled him to measure the masses precisely and show that their mean was the atomic weight of neon as determined by its density.

The positive rays had some interesting secondary consequences. They showed the existence of several previously unknown compounds, including, for example, a molecule of hydrogen with 3 atoms, the existence of which prevented the earlier discovery of heavy hydrogen by masking the mixed molecules DH, although J. J. had advanced the opinion that there were two kinds of "3" in his experiment.

Quite early in the course of these researches J. J. pointed out the merits of positive rays as a method of chemical analysis, stressing the small amount of material required. For a long time no application was made, but now the method, as is well known, has found an important place in technology, especially for the analysis of oils.

J. J. was an indomitably hard worker. An incomplete list of his papers numbers 187, mostly quite substantial. He wrote a textbook on electricity and one on the properties of matter, the last a part of a series which he and Poynting undertook together, although Poynting did most of the others. He also wrote his *Conduction of Electricity through Gases*, which passed through three editions, each much larger than the last. Then there were monographs such as the *Silliman Lectures* already quoted, *The Discharge of Electricity from Gases, Corpuscular Theory of Matter, Rays of Positive Electricity, Motion of Vortex Rings, Application of Dynamics to Physics and Chemistry*, and *The Electron in Chemistry*, the last an application of electron theory to chemistry rather on the lines and roughly contemporary with the work of Lewis and Langmuir, which he published after World War I.

But it may fairly be said that Thomson's greatest contribution to physics was not in his own work but in the work of the school that he founded in the Cavendish Laboratory, which trained a large number of the ablest physicists of his day of almost every civilized nation. Eight of his pupils have received the Nobel prize. A great part of the work of this school was devoted to the elucidation of the intricacies of electric conduction and discharge in gases, and many of J. J.'s papers, both theoretical and experimental, were on this theme. He was specially fascinated by the electrodeless discharge, which he was one of the first to study; a paper he wrote on it when he was over 70 is still quoted, and his work on recombination of ions is the basis of much modern theory.

Conclusion

In many ways J. J. was a man of paradox. Although he was a great experimentalist with a remarkable power of diagnosing the diseases of a piece of apparatus, he was very clumsy with his hands—except indeed in penmanship, his handwriting being both clear and forceful. In designing apparatus he always used the simplest means and had, I think, no great love of apparatus for its own sake. He would never, for example, have developed C .T. R. Wilson's cloud technique into a cloud chamber, though he used it to measure e. Again, although he was an accomplished mathematician with a mastery of the techniques of his day, he seldom used mathematics as an indication to where a theory should lead. The ideas were usually intuitive, based on visualization and analogies, not on mathematics. When occasionally he departed from this practice, as when he rejected the planetary atom for reasons of stability, the mathematics let him down. He was not afraid of making mistakes and put forward his fair share of ideas which failed. He was always intrigued with the conception of energy and of its different forms and made more than one attempt to reduce them all to the kinetic energy of imaginary particles, an idea which may perhaps yet prove to be true.

Outside the laboratory—or indeed in the laboratory during the break for tea which he instituted—he was a man of wide interests and usually preferred to discuss events or people rather than physics. There were few subjects, except music, which he could not discuss and fewer still in which he took no interest. When he became master of Trinity Col-

lege, he enjoyed the college life, especially the contacts which it gave him with undergraduates, and it was by no means exclusively the intellectual ones with whom he was friends. Although he had never been particularly good at games, he was keenly interested in them, and of some at least was a shrewd critic.

He judged other physicists largely by the originality they displayed but was on the whole more appreciative of other men's experiments than of their theories. He was very reserved in speaking of those things about which he really cared but had warm feelings and strong beliefs. To him physics was something to be approached with the enthusiasm which he valued so highly in the young physicist, but also with a certain reverence, the reverence due to the infinite.

"A great discovery is not a terminus, but an avenue leading to regions hitherto unknown. We climb to the top of the peak and find that it reveals to us another higher than any we have yet seen, and so it goes on. The additions to our knowledge of physics made in a generation do not get smaller or less fundamental or less revolutionary, as one generation succeeds another. The sum of our knowledge is not like what mathematicians call a convergent series . . . where the study of a few terms may give the general properties of the whole. Physics corresponds rather to the other type of series called divergent, where the terms which are added one after another do not get smaller and smaller, and where the conclusions we draw from the few terms we know, cannot be trusted to be those we should draw if further knowledge were at our disposal."

G. Dahlberg, Human Geneticist

Gunnar Dahlberg, professor of human genetics and director of the Swedish State Institute of Human Genetics at the University of Uppsala, died on 25 July 1956, just a month before his 63rd birthday. He was educated in medicine at Uppsala and admitted to practice in 1920. His interest, however, was in research, and in 1921 he became research assistant in the newly established State Institute of Race Biology at Uppsala (Statens Rasbiologiska Institut) under Lundborg, whom he succeeded as professor and director in 1936. In 1945 a cerebral hemorrhage paralyzed his right side and left him with a permanent impairment of speech, but within 2 months he was back at work and continued until ill health caused his retirement in 1955.

Dahlberg's first major work was a monograph on *Twin Births and Twins from a Hereditary Point of View*. This was the dissertation for which he received the M.D. degree from Uppsala in 1926. This comprehensive work signalized the resumption of interest in twins under the influence of modern genetics, demography, and anthropometry. It contained detailed data in 191 pairs of monozygotes and 52 pairs of dizygotes, diagnosed by the polysomatic method, and a hypothesis of twinning as due to hereditary predisposition to double formation in the oocyte before the reduction division. The center of Dahlberg's interest, which dominated his subsequent work, was indicated in a single chapter on "Hereditary factors in populations," in which evolutionary forces such as selection and mutation on gene frequencies were evaluated by a simple calculus.

Dahlberg's chief contributions thereafter were concerned with theories of the genetical struture of human populations, culminating in his last book, *Mathematical Methods for Population Genetics* (1947), and his paper on "Genetics of human populations" in *Advances in Genetics*, volume 2, 1950. Of particular importance was his emphasis on the existence, within a total population, of partial populations, called isolates, within which random mating occurs. For Dahlberg [see *Human Biology*, **14**, 372 (1942)] the isolate concept underlies the concept of race and provides the rationale for a genetical theory of race formation. Since Dahlberg's influence helped to give a new form and direction to the study of human genetics, it may be well to quote his own statements [*Advances in Genetics*, **2**, 96 (1950)]:

"Human genetics have arisen from plant and animal genetics. In Germany this branch of research came to be influenced by ideas about race, as can be seen, for example, in the German term, *Rassenbiologie*. In that country it gradually came to enter into, and be influenced by, the Nazi ideology.

"In England, human genetics came to be linked with Galton's eugenics (the doctrine of the well-born), and was therefore extensively directed towards the investigations of families considered to be of particularly high quality.

"Thus, with human genetics focussed on population problems connected with politics as it was in England and Germany, no very important research was done. The main result from this point of view was subjective colored propaganda literature without any scientific value worth the name."

The change which came about in Dahlberg's scientific lifetime is illustated by the change in activity of his own institute from race biology to human genetics; Galton's Laboratory of Eugenics at University College, London, has become a laboratory of human genetics; the Eugenics Record Office at Cold Spring Harbor (founded 1910) has been absorbed by the department of genetics of the Carnegie Institution of Washington, and similar changes have occurred elsewhere. Dahlberg's influence was to direct human genetics into channels of research on evolutionary forces at work in human populations, and for this research he provided not only the strongly held and stated views quoted here but useful simple methods (sometimes called Mendelian algebra) and ideas to be tested by them. His final views on the essential problems of human genetics are in the concluding paragraph of the aforementioned paper: "But necessary though it may be to develop the theoretical-cum-mathematical side of the problems, the primary need is for empirical investigations of the processes taking place in human populations. We require both knowledge of the frequency of intermarriage, assortative mating, the fomation of isolates, etc., and also investigations of the actual frequency of individual characters in populations. We have, however, still very little possibility of comparing the make-up of a population at different junctures, or of comparing different populations at the same juncture. A great deal must be done to achieve an empirical foundation for the assessment of populations from the viewpoint of heredity. But this must be regarded as a very important task for human genetics to carry out" [*Advances in Genetics* **2**, 97 (1950)].

Dahlberg founded in 1948 the journal *Acta Genetica et Statistica Medica* for the publication of research on the aforementioned problems. He was its editor until his death.

Although Dahlberg may seem to have taken an antieugenical position, he made many contibutions to race betterment in the broader sense. His studies of the effects of alcoholism on the Swedish population (which resulted in his becoming what he referred to as a "statistical teetotaler") and his application, as collaborator or adviser, of quantitative methods to a wide variety of medico-social problems (he was an active adviser in 119 medical monographs) left an enduring mark on social medicine in Sweden.

His interest in human problems expressed itself in more personal ways as well: active assistance to refugees from Nazism and Fascism, recognized by the award to him from Great Britain of the King's Medal for Service in the Cause of Freedom. His personal convictions rested on a strong sense of scientific honesty, set forth in respect to the prostitution of genetics in Germany in his popular book of 1942, *Race, Reason, and Rubbish*. He later reacted with similar forthrightness when the Communists suppressed the development of genetics.

Something more than potential contributions to one branch of science is lost when a man like Gunnar Dahlberg dies, for the struggle to attain a life based on reason, which his life exemplified, is one that all scientists face.

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News of Science

AAAS Cardiovascular Research Award

The AAAS will award this year for the first time the AAAS–Ida B. Gould memorial award for research on cardiovascular problems. The award, which consists of a citation and $1000, is intended to stimulate research, particularly basic research, in the cardiovascular field.

The winner will be chosen by a committee of judges of which Paul Dudley White is chairman. The other judges were selected by the principal organizations in the United States that are active in the cardiovascular research field: C. Sidney Burwell (Helen Hay Whitney Foundation), Robert P. Glover (American College of Cardiology), Dickinson W. Richards (Life Insurance Medical Research Fund), Francis Wood (American Heart Association), and J. Franklin Yeager (National Heart Institute). Funds for the award, which will be continued on an annual basis, are provided by the Richard and Hinda Rosenthal Foundation of New York.

Church Service on Science and Religion at Time of AAAS Meeting

Donald Harrington, minister of the Community Church in New York, has announced that he is planning a special service at 11 A.M. on the morning of 30 Dec. on the subject, "Science and Religion." The entire service will be built around this theme, and in place of a sermon Harrington has arranged a discussion between himself and a number of scientists on "The challenge of science to religion and of religion to science."

Participants in the AAAS annual meeting, which is convening in New York 26–31 Dec., are cordially invited to attend this service. The Community Church is at 40 E. 35 St., just a few blocks from the AAAS meeting headquarters.

Archeology in the Marquesas

The results of the first archeological expedition ever made to the Marquesas Islands in the South Pacific have been reported by Harry L. Shapiro, chairman of the department of anthropology at the American Museum of Natural History, New York, and leader of the expedition. The trip was financed by Mr. and Mrs. Cornelius Crane, who accompanied the museum team.

The Marquesas are a group of 11 volcanic islands, six of which are inhabited. They are located approximately half-way between South America and Australia. Covered with mountains and luxuriant valleys, the islands are noted for their beauty. They were used by Herman Melville as the setting for his novel *Typee*, and the painter Paul Gauguin, who is buried on one of the islands, spent his last days there.

Early records show that when the first Europeans reached the Marquesas some 150 years ago, there was a Polynesian population of approximately 100,000. Shapiro states that these inhabitants were among the peoples most seriously affected by the diseases introduced by Europeans, so that when he first visited the islands in 1930 the population had dwindled to 1600. However, he now estimates that the population has increased to about 3500 persons of Polynesian ancestry.

Although ethnologists have studied the Marquesan culture and archeologists have mapped the huge stone surface structures known as meiaes, the American Museum's expedition marks the first attempt at excavations. Expedition members worked at several sites in the bays of Nukuhiva, the largest island in the group. There they discovered the remains of a culture definitely predating European contact and perhaps going back to the very early stages of Marquesan life.

According to Shapiro, scholars of cultural history in the South Pacific have been particularly interested in obtaining dates for an early culture in the Marquesas because of the light those dates would shed on the civilization of the area as a whole. Several carbon samples were taken from two caves on Nukuhiva for radiocarbon dating.

Inscribed in the rocks along the shore, the field party discovered line drawings or pictographs of human beings, whales, and other animals. Some of the drawings were hidden from sight under an extensive, rocky concretion, indicating that they must have been drawn before the concretion was formed. Therefore, the pictographs may very well represent a record of a very ancient Marquesan culture.

Another site was discovered in a sand dune that had been broken into by a tidal wave. The dune contained artifacts such as fishing gear, shell jewelry, and stone adzes. Several of the fish hooks were similar to those known to be used on Easter Island, which is some 2000 miles away.

The same site also yielded the remains of a burial which gives every indication of having been that of an important person. An articulated skeleton of a middle-aged woman resting on the scapula of a whale was supported by a circle of female skulls. Within the circle was a pile of loose bones, the remains of several skeletons.

Interferometric Comparator

The National Bureau of Standards has developed an interferometric comparator that makes routine comparisons of length to the nearest ten-millionth of an inch. Designed by T. R. Young and J. B. Saunders of the engineering metrology laboratory, the instrument will be used to check lengths of industry's master gage blocks, which control the tolerances of mass-produced machine parts.

An instrument of this accuracy has been greatly needed because of the extremely small dimensional tolerances now required for parts used in the guided-missile, jet-aircraft, machine-tool, and other industries. At present the bureau calibrates master gage blocks to an accuracy of 1 part in 1 million—that is, to the nearest millionth of an inch for inch-long blocks.

Malaria Eradication in Mexico

Some 3 million houses in the malarious areas of Mexico will be sprayed starting 1 Jan. 1957 in the largest undertaking of its kind ever attempted in this hemisphere. This enormous enterprise is aimed at wiping out the mosquitoes that transmit malaria, thus effecting the eradication of this disease in Mexico. The Pan-American Sanitary Bureau, Regional Office of the World Health Organization, which has stimulated the eradication program, is collaborating by furnishing technical assistance in this campaign. The United Nations Children's Fund is providing large quantities of insecticides, trucks, and other essential materials, but the Mexican Government will furnish most of the funds and direct the program.

PASB has also set up a Coordination Office of its Malaria Eradication Program in Mexico City to coordinate the national malaria eradication programs now under way or in preparation throughout this hemisphere. The present status of these national programs is as follows: of the 20 countries originally infected, two (United States and Chile) have completed eradication; ten of the 18 still infected have begun eradication campaigns (Argentina, Brazil, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Dominican Republic, and Venezuela); three have completed plans for converting control programs to eradication campaigns (Nicaragua, Panama, and Paraguay); and five are either surveying for, or are considering converting to, eradication campaigns (Bolivia, Colombia, Costa Rica, Cuba, and Peru). Canada and Uruguay have no malaria problem.

In the Caribbean territories, a similar situation prevails: five of the 16 originally infected have eradicated malaria (Antigua, Barbados, French Guiana, Martinique, and Puerto Rico); four are well advanced in eradication campaigns (British Guiana, Canal Zone, Saint Lucia, and Tobago); and seven have plans for converting control programs to eradication (Belice, Dominica, Grenada, Guadeloupe, Jamaica, Surinam, Trinidad).

New ARDC Agency for Small Business

The Air Research and Development Command, Baltimore, Md., has established a new procurement agency, the Executive for Small Business. The agency has been designed to increase utilization of small businesses possessing a technical capability in research and development areas. Located in ARDC Headquarters, the Executive for Small Business will have Air Force field development offices at each of the ARDC centers.

The new agency will provide an efficient counseling service for representatives of small business. In addition, ARDC will have greater access to source information concerning organizations with potential research and development procurement possibilities. John C. Eiden, former administrative officer in the Office of the Director of Research and Development, Headquarters, USAF, has been named head of ARDC's new program.

Cancer Society on Smoking

A summary review of information on the relation of cigarettes to lung cancer has been published by the American Cancer Society. The pamphlet, drawing on the 4-year ACS study of the smoking habits of 188,000 men, was written in response to many requests for a concise, factual statement for the public on lung cancer and cigarettes. "This booklet," the pamphlet says, "seeks to provide a summary of a problem whose elements are changing and developing each year. It is tentative and incomplete. . . ."

In an eight-page section of questions and answers dealing mainly with findings of the ACS statistical study, the booklet points out that field work on the study "has been almost entirely completed: a final report will be made covering the study and analyzing about 12,000 deaths. The study was originally planned for three to five years and four annual follow-ups have provided necessary data. Statisticians estimated that they would need 200,000 person-years of experience for accurate conclusions. The final analysis will cover more than 700,000 person-years of experience."

In answer to the question "Shall I give up smoking?" the booklet says: "The American Cancer Society feels that this must be a personal decision based on evidence available today. The evidence suggests that cigarettes are a health hazard. The specific effect of cigarette smoking on a particular individual cannot be predicted."

Earlier, the pamphlet says, "The American Cancer Society has no plans for a campaign against cigarette smoking. . . . The final decision on whether to smoke cigarettes rests with the individual, who will probably make up his mind in consultation with his doctor. Physicians will surely be prime movers in shaping attitudes toward cigarettes."

Control of Cholesterol Production

A way has been found to control, in laboratory animals, the natural production of cholesterol, the fatty substance that accumulates in human arteries and is implicated in atherosclerosis and coronary disease. Atherosclerosis is the chief cause of death in the United States, leading to 370,000 deaths a year. By feeding a cholesterol-free diet containing 1 percent delta-4-cholestenone, a synthetic compound related chemically to cholesterol, Daniel Steinberg and Donald S. Frederickson of the National Heart Institute have been able to depress the cholesterol in blood serum of rats to as much as 44 percent below that of control animals on a similar diet lacking the delta-4-cholestenone.

Injections of labeled (radioactive) acetate demonstrated that the delta-4-cholestenone was interfering with the normal mechanism for manufacturing cholesterol. Acetate is taken up by the liver to make cholesterol, and in normal animals radioactive acetate can be found in the liver cholesterol with a Geiger counter shortly after injection. The investigators measured only 5 percent as much labeled acetate in the liver cholesterol of the rats that were fed 1 percent delta-4-cholestenone as in the normal rats 2 hours after injection.

Steinberg and Frederickson caution that delta-4-cholestenone itself should not be considered as a practical drug for the treatment of high blood cholesterol in human beings. Its use is definitely haz-

ardous at this stage of knowledge. Steinberg discussed the findings recently in Washington, D.C., during the annual convention of the Association of Military Surgeons of the United States. A report of the research is scheduled for publication in the *Annals of the New York Academy of Sciences.*

New ACE Information and Research Division

The American Council on Education has established a new Office on Statistical Information and Research, with Coleman R. Griffith, former provost of the University of Illinois as director. The office, which will be operated in Washington, D.C., as part of the council's central program, has a 5-year grant of $375,000 from the Carnegie Corporation of New York.

Among the objectives of the new unit will be the analysis of data relating to higher education, encouragement of existing research agencies to fill gaps in present knowledge, improvement in methods of gathering statistical information, and correlation and interpretation of facts from various sources having special value for educational policy-making. Griffith, who will be on leave from the University of Illinois, will direct the office on a part-time basis until 1 Feb. 1957, when he will assume full-time duties in Washington.

Elmer D. West, educational specialist on the staff of the National Security Agency, has been appointed assistant director of the new office. He recently completed a special 6-month research project for the council which resulted in a book entitled *Background for a National Scholarship Policy.* West is on full-time duty setting up the facilities for the Washington headquarters. The office will operate under a policy committee, of which Frederick L. Hovde of Purdue University is chairman.

News Briefs

■ A set of 32 photographs of Russian doctors and scientists has been received by the National Library of Medicine's art section; in exchange, the library has sent a shipment of duplicate portraits of American physicians and surgeons.

■ To confirm the report about Russian nuclear physicist Peter Kapitsa's refusal to work on the Soviet atomic bomb project for conscientious reasons [*Science* **124**, 361 (24 Aug. 1956)], a staff member of the British publication *Peace News* tried the improbable procedure of calling Kapitsa by international telephone. The call went through without difficulty, and Kapitsa confirmed that he had refused, and still refuses, to participate in the development of nuclear energy for military purposes.

■ The eighth annual report of the Australian Commonwealth Scientific and Industrial Research Organization for the year ending 30 June 1956 has been made available. This report deals with a great variety of research in such diverse fields as entomology, plant industry, animal health, forest products, industrial chemistry, and radiophysics. It may be obtained from CSIRO, 314 Albert St., East Melbourne, Australia.

Scientists in the News

LAWRENCE G. DERTHICK, superintendent of schools in Chattanooga, Tenn., has been named United States Commissioner of Education by President Eisenhower.

Exceptional Service awards have been given by the Air Force to JOHN W. GARDNER, president of the Carnegie Corporation, DONALD W. HASTINGS, professor of psychiatry and neurology at the University of Minnesota, GEORGE E. VALLEY, professor of physics at Massachusetts Institute of Technology, and HARRY WEXLER, chief of the science services division of the U.S. Weather Bureau. The Exceptional Service award consists of a medal and formal citation and is the highest civilian award given by the Air Force. The medals were presented by Donald A. Quarles, Secretary of the Air Force, on 30 Nov. All four of the recipients were honored for their service as members and chairmen of panels of the Air Force Scientific Advisory Board.

The following Russell L. Cecil awards for science writing about the rheumatic diseases were presented by the Arthritis and Rheumatism Foundation during its recent annual meeting in New York: to PETE COUTROS, newspaper article *New York Daily News*; LAWRENCE GALTON, magazine article, *Better Homes and Gardens*; and JAY E. RAEBEN, television script, American Broadcasting Company. The three men were cited for writing "which during 1956 has contributed most to strengthen man's efforts to conquer arthritis and rheumatism, the nation's foremost chronic and crippling diseases."

ROBERT R. MARSHAK of Springfield, Vt., has been appointed professor of veterinary medicine and chairman of the department at the School of Veterinary Medicine, University of Pennsylvania.

ISIDOR I. RABI, Higgins professor of physics at Columbia University and a Nobel prize winner, is visiting institute professor at the Massachusetts Institute of Technology during the current fall term. The institute professorship was established especially to permit men of highest achievement to study and teach at M.I.T. in fields of their own interest, without the restrictions of traditional departmental boundaries.

BERNARD S. SCHWEIGERT has been appointed director of research and education of the American Meat Institute Foundation at the University of Chicago, and DELBERT M. DOTY and CHARLES F. NIVEN, JR., have been named associate directors. The foundation maintains laboratories on the university campus and has a staff of more than 50 scientists engaged in research related to the production of livestock and the processing and utilization of products derived from livestock.

Reorganization of the foundation's administrative staff was made necessary on 30 Sept. by the death of HENRY R. KRAYBILL, scientist and educator who had aided in the creation of the foundation and had served as its director since 1947 when it first began operations. All three of the new administrative officers have held positions of research and administrative responsibility at the foundation for 8 or more years, all served with Kraybill as assistant directors in charge of specific areas of research, and all hold professorial appointments at the University of Chicago.

CHALMER G. KIRKBRIDE, former president and chairman of the board of directors of Houdry Process Corporation, Philadelphia, Pa., joined the Sun Oil Company, Philadelphia, on 1 Dec., as executive director of the research, patent, and engineering departments.

Also at Sun, CHARLES L. THOMAS, formerly associate director of the research and development department, has been named director. He succeeds J. BENNETT HILL, who retired on 30 Nov.

WILFRED BLOOMBERG has been chosen to head the Southern Regional Education Board's program in mental health training and research. Bloomberg is chief of the psychiatry and neurology service, Veterans Administration Hospital, Boston, Mass. He will assume his new post on 1 Jan. The regional health program was initiated at the Southern Governors Conference in 1953, when the governors of 16 southern and border states requested the Regional Education Board to study the South's resources and potentials for training and research on problems of mental health.

GEORGE C. KENNEDY, geophysicist at the University of California, Los Angeles, has received this year's Mineralogical Society of America award. The honor is presented annually to a scientist under the age of 36 for the most outstanding contribution to the mineralogical profession. The citation was based on Kennedy's research in three areas that are related to the way minerals were deposited in the earth's crust: solubility of solids in steam at very high temperatures and pressures; the relation of pressure, temperature, and quantity of gases; and phase changes of minerals under high pressure.

LYTT I. GARDNER, professor of pediatrics at the State University of New York College of Medicine in Syracuse, has been appointed professor of pediatrics at the Yale University School of Medicine.

At the 10th International Congress of Entomology recently concluded in Montreal, professor emeritus J. CHESTER BRADLEY of the State College of Agriculture at Cornell University was elected an honorary life member of the congresses. The only other North American to hold this honor is professor emeritus O. A. JOHANNSEN, of the State College of Agriculture.

Bradley is a member of the permanent committee that serves as a liaison between the congresses, which are held once in 4 years. The Montreal meeting was the second to be held outside Europe, the fourth having been held in Ithaca in 1928.

REINHOLD RUDENBERG, professor emeritus of Harvard University and inventor of the electron microscope, was honored on 19 Nov. when a document and medal conferring the rank of honorary senator of the Berlin University of Technology was presented to him by the German consul in Boston, Mass. His new rank, which makes him an honorary member of the governing body of Berlin University, was conferred in recognition of "outstanding scientific achievements" spanning more than 40 years in the field of electrical power engineering. Berlin University made Rudenberg an honorary professor in 1927.

JAMES H. WIEGAND, former chairman of the department of chemistry and chemical engineering at the Southwest Research Institute, San Antonio, Tex., has been appointed head of the newly formed engine research department of the Solid Rocket Plant, Aerojet-General Corporation, Sacramento, Calif., and will be concerned with expanding research on the interior ballistics of solid propellant rocket engines.

S. K. RUNCORN, director of the physics department at King's College, Newcastle, England, will lecture at the University of Texas, Austin, 10–21 Dec. His ten public lectures on theories of the earth's present and past magnetic behavior will be of interest to geologists as well as physicists.

G. DONALD WHEDON has been appointed assistant director of the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Md. In addition to this new assignment, he will continue his research and clinical responsibilities as chief of the metabolic diseases branch in the Clinical Investigations Division of the institute.

JAMES M. HUNDLEY, former chief of laboratory research, as well as chief of the Laboratory of Nutrition and Endocrinology, NIAMD, left the institute on 1 Sept. on a 2-year leave of absence. He is now administering a research program for the United Nations Childrens Emergency Fund and the Food and Agriculture Organization of the United Nations, with headquarters in the U.N. Building, New York.

ALAN H. SHAPLEY, a radio physicist and vice chairman of the U.S. National Committee for the International Geophysical Year, will head a new section of sun-earth relationships at the Boulder Laboratories of the National Bureau of Standards. The section will centralize work that Shapley has been engaged in at Boulder for some time. It will also permit a more closely coordinated program in the study of the sun and its effects on radio communication, the use of solar and geophysical data to forecast short-wave radio communication conditions, and the scientific coordination of the many Bureau field stations that are making radar-type observations of the upper atmosphere.

An important phase of the new section's work will be concerned with the effect on radio communication of the ionosphere, the highly electrified region of the upper atmosphere produced by solar radiation and greatly influenced by high-speed particles discharged from the sun. Systematic measurements of the height and density of the ionospheric layers are made all over the world and used in these analyses.

In addition to research, the section is to be concerned with improving the Bureau's comprehensive 24-hour radio warning service, which is supervised from the NBS Boulder Laboratories. This service uses knowledge of solar effects and other data to issue warnings of impending changes of conditions that may affect short-wave communications over long distances.

FORREST E. LINDER, former chief of the demographic and social statistics branch of the United Nations Statistical Office, has been named director of a new Public Health Service program to survey the nature and extent of illness and disability in the population each year. The year-by-year survey, authorized by the past Congress, also will include data on medical services received by the ill and disabled. The last previous Federal survey of this type was in 1936.

JOHN ROCK of Harvard University has retired from active teaching and become clinical professor of gynecology, emeritus. A specialist in the physiology of human reproduction and a teacher of both predoctoral and graduate students at the Harvard Medical School, Rock has also devoted much time to exploring the mechanical as well as the metabolic disturbances of male and female infertility. In collaboration with Arthur T. Hertig, professor of pathological anatomy, he participated in the collection and description of the early stages in the development of the human ovum. These studies also included observation on abnormal development during gestation.

Rock received an S.B. degree from Harvard in 1915 and an M.D. degree in 1918. A member of the staff of the medical school since his appointment as an assistant in obstetrics in 1922, he became clinical professor of gynecology in 1947. At the Free Hospital for Women, in Brookline, Mass., he established one of the first fertility clinics in this country and served as its director for nearly 30 years. At present he serves as consulting gynecologist and director of the Rock Reproductive Study Center at the Free Hospital for Women and as a member of the board of consultants, Massachusetts General Hospital. His professional affiliations and awards have been numerous and widespread, both in this country and abroad.

DONALD D. VAN SLYKE of Brookhaven National Laboratory has been elected a member of the Royal Academy of Sciences of Denmark.

THEODORE WEAVER, manager of the process development department of the Fluor Corporation, Ltd., Los Angeles, Calif., has received the junior award of the American Institute of Chemical Engineers. The award is given annually to encourage improvement in the quality of papers contributed to the publications of the institute by its younger members.

FRANCIS BITTER, professor of physics at Massachusetts Institute of Technology, has been named associate dean of the institute's School of Science.

HANS T. HESSELBERG recently received the annual prize of the International Meteorological Organization at a ceremony that took place at the Norwegian Meteorological Institute in Oslo. The prize was created by the World Meteorological Organization to perpetuate the memory of the nongovernmental international organization which that specialized agency of the United Nations has succeeded. The award is presented once a year to a personality who has made an important contribution to meteorology and has devoted himself to the cause of international meteorological organizations. Hesselberg was director of the Norwegian Meteorological Institute for 40 years. He also was president of the International Meteorological Organization from 1935 to 1946.

JAMES B. CONANT, United States Ambassador to West Germany, has received an honorary doctorate of natural science from the University of Hamburg.

WILLIAM H. EWING and PHILIP R. EDWARDS of the Public Health Service office in Atlanta, Ga., have received the 1956 Kimble Methodology research award for their work in developing improved methods for identifying bacterial causes of typhoid, infantile diarrhea, food poisoning, and other enteric disorders. The award, sponsored by the Kimble Glass Company, includes $1000 and an inscribed plaque.

GEORGE E. ARMSTRONG, vice president for medical affairs at New York University, and Surgeon General of the Army from 1951 to 1955, has received the 1956 Founder's medal of the Association of Military Surgeons of the United States.

Recent Deaths

CLARENCE A. CHANT, Toronto, Canada; 91; professor emeritus of astrophysics and director emeritus, David Dunlop Observatory, at the University of Toronto; 18 Nov.

SIEGWART HERMANN, New York, N.Y.; 70; research chemist and consultant; 27 Nov.

ANDREW H. HOLT, Worcester, Mass.; 66; head of the department of civil engineering at Worcester Polytechnic Institute; 22 Nov.

WALDEMAR B. KAEMPFFERT, New York, N.Y.; 79; science editor of the *New York Times*; 27 Nov.

FRANK W. REED, Athens, Ohio; 75; former professor of mathematics at Ohio University; 22 Nov.

BERNHARD J. STERN, New York, N.Y.; 62; lecturer in sociology at Columbia University; 22 Nov.

LIONEL WHITBY, London, England; 61; bacteriologist and hematologist; 24 Nov.

DERWENT S. WHITTLESEY, Boston, Mass.; 66; professor of geography at Harvard University; 25 Nov.

Education

■ Wellcome Trustees, London, England, has awarded a $69,000 grant to the School of Medicine of the University of Pennsylvania. This will support for a period of 5 years a Wellcome associate research professorship in the department of anesthesiology. The first appointee to the new chair is Henry L. Price.

(The Wellcome Foundation was established by the late Sir Henry S. Wellcome who was born in Almond, Wis., 100 years ago and who died in England in 1936. The Wellcome Trust, holder of all the shares of the Wellcome Foundation, is headed by Sir Henry H. Dale, English scientist and Nobel prize winner. The Burroughs Wellcome and Company, Tuckahoe, N. Y., is a part of the Wellcome Foundation.)

■ Federal support for 81 educational programs totaled more than $1.6 billion during the 1954–55 school year, according to a new biennial report of the Office of Education, Department of Health, Education, and Welfare. Entitled *Federal Funds for Education*, the new publication also lists many statistics for the 1955–56 school year and for several earlier years. Values of commodities and services as well as funds are included in the tabulations.

The new total of $1,616,654,000 is less than half of the 1948–49 sum, which was $3,500,817,000. A significant factor in the decrease was veterans' education and training. Federal support of this program was $2,700,184,000 in 1948–49, or about four times the amount for 1954–55.

A significant increase in Federal assistance for school construction in federally affected areas is shown. Whereas $122,767,000 was expended for this program in 1954–55, only $2,956,000 was disbursed 4 years earlier. The affected areas include districts in which Federal ownership of property has reduced taxable valuations appreciably, or Federal activities have caused burdensome school enrollments through the influx of workers and their families.

The 163-page bulletin, the 13th biennial issue on Federal support of education, was prepared by Clayton D. Hutchins, Albert R. Munse, and Edna D. Booher of the School Finance Section, Office of Education. Copies are available at 60 cents each from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

■ At a banquet held on 15 Oct. to celebrate the tenth anniversary of the incorporation of the Oak Ridge Institute of Nuclear Studies, S. R. Sapirie, manager of the Atomic Energy Commission's Oak Ridge Operations Office, presented the institute with a deed for 38 acres of land in Oak Ridge. In return, he received a check from Paul M. Gross, vice president of Duke University and president of ORINS. Heretofore, the entire tangible property of the institute has been the corporation seal. All the buildings, furniture, equipment, and research apparatus used by the institute for the past 10 years belonged to the AEC. The newly acquired land is to be the site for a permanent headquarters, a $3,250,000 project still in the planning stage.

■ Grants totaling $4,065,000 have been awarded by the National Science Foundation to 16 colleges and universities in the United States to support academic-year institutes designed to help high-school science teachers improve their knowledge of science subject matter. An estimated 750 high-school science and mathematics teachers will be enrolled in the institutes, which begin in September 1957.

Each teacher will pursue a program of study in the sciences and mathematics planned especially for him and conducted by leaders noted not only for competence in their fields but for skill in presentation. The grants will provide stipends of $3000 each to approximately 50 teachers in each institute. Additional allowances for dependents and travel will also be provided.

Academic-year institutes are an outgrowth and extension of the foundation's summer institute programs, now in their fifth consecutive year. Two academic-year programs are now operating—at the University of Wisconsin and at Oklahoma Agricultural and Mechanical College. These are being renewed. The other 14 grants provide for the establishment of new institutes. The institutes at the University of Chicago and the University of Illinois are for teachers of high-school mathematics only; the others will provide work in the various fields of science as well as in mathematics.

The following list of grant recipients includes the persons to whom inquiries or application should be addressed: Harvard University, Dean Francis Keppel, Graduate School of Education; Ohio State University, Prof. John S. Richardson, College of Education; Oklahoma Agricultural and Mechanical College, Prof. James H. Zant, department of mathematics; Oregon State College, Prof. Stanley E. Williamson, department of science education; Pennsylvania State University, Mr. William H. Powers, arts and sciences extension; Stanford Univer-

sity, Prof. Harold M. Bacon, department of mathematics; Washington University, Dean T. F. Hall; University of Chicago, Prof. E. P. Northrop, mathematics staff; University of Colorado, Prof. William E. Briggs, department of mathematics; University of Illinois, Prof. Joseph Landin, department of mathematics; University of Michigan, Prof. Freeman D. Miller, department of astronomy; University of North Carolina, Prof. Edwin C. Markham, department of chemistry; University of Texas, Prof. Robbin C. Anderson, department of chemistry; University of Utah, Prof. T. J. Parmley, department of physics; University of Virginia, Prof. James W. Cole, department of chemistry; University of Wisconsin, Prof. C. H. Sorum, department of chemistry.

■ The University of Michigan has dedicated the Ford nuclear reactor, a swimming-pool type of reactor built for the Memorial-Phoenix Project with a $1 million gift from the Ford Motor Company Fund. The Phoenix Project is the university's program on the peaceful uses of atomic energy created in memory of its World War II dead. Addition of the million-watt reactor provides the institution with complete facilities for research in all fields of atomic energy.

Grants, Fellowships, and Awards

■ The deadline date for receipt of applications for the National Science Foundation's postdoctoral fellowships is *24 Dec.* These awards are available to scientists who hold the M.D., the D.D.S., or the D.V.M. degree. The stipend is $3800, with family and travel allowances. This is one of the programs with which the National Academy of Sciences–National Research Council assists the foundation. Application material may be obtained from the Fellowship Office, NAS–NRC, 2101 Constitution Ave., Washington 25, D.C.

Other fellowship programs with which the NAS–NRC is concerned are described on page 977 of the 16 Nov. issue of *Science*. In that listing, the deadline date for NSF graduate fellowships is incorrectly given as 24 Dec.; the correct date is *7 Jan.*

■ Applications are now open for places in the 1957–58 Atomic Energy Commission special fellowship program in industrial hygiene, according to an announcement by the Oak Ridge Institute of Nuclear Studies, which administers the program for the commission. Industrial hygiene fellowships leading to the master's degree are open to college graduates in engineering or the basic sciences. The rapidly expanding field of industrial hygiene includes the study and control both of the more common occupational diseases and of such other environmental factors affecting employee health as radiation, heat, fatigue, and mechanical hazards associated with plant or laboratory operations.

The industrial program provides for 9 months of graduate training at Harvard University's School of Public Health or at the University of Pittsburgh Graduate School of Public Health. Course work varies with the university selected and with the interests and undergraduate preparation of the individual. All fellows are required to take course work in public health and biostatistics; electives may include engineering, health physics, toxicology, industrial medicine, and related subjects.

Basic fellowship stipend is $2500, with an additional $350 allowed for spouse and $350 for each dependent child. Fellowship awards include payment of normal tuition and fees required by the university; a travel allowance of 6 cents per mile for the fellow (not dependents) from the place of application to his assigned university; and financial assistance to attend the annual meeting of the American Industrial Hygiene Association. One or more years of graduate work or industrial experience may qualify a fellow for an additional $200 in the basic stipend.

Applicants may designate their choice of institutions and, when possible, assignments will be made accordingly, although ORINS cannot guarantee compliance with the choice. Requirements include a bachelor's degree in engineering or a basic science, acceptability for graduate work at the assigned university, and U.S. citizenship; applicants must be under 35 years of age.

Additional information and application blanks may be obtained by writing the Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tennessee. Completed applications, supporting letters of reference, and transcripts must reach ORINS not later than *1 Mar. 1957*.

■ The U.S. Atomic Energy Commission has raised the stipends for its special fellowships in industrial medicine to $5000 for the academic year 1957–58. The other provisions in the current announcement [*Science* **124**, 929 (9 Nov. 1956)] will remain the same.

■ The National Science Foundation and the U.S. Public Health Service have increased their fellowship stipends to make them more nearly comparable to awards from other sources. Stipends will be increased for all awards activated on and after 1 Jan. 1957.

The new stipends at the predoctoral level for the first year will be $1600; intermediate year, $1800; terminal year, $2000 (former stipends: $1400, $1600, and $1800, respectively). The new stipends at the postdoctoral level for the first year will be $3800; second year, $4200; third year, $4600 (former stipends: $3400, $3700, and $4000, respectively). Allowances, which include tuition, certain travel expenses, and $350 for each dependent, will remain unchanged.

■ The Public Health Service has allocated $468,025 to other Federal agencies for research activities in community air-pollution work during 1957. Agreements have been concluded with the Departments of Agriculture, Commerce, and Interior, and the Library of Congress for this work.

The Weather Bureau, Department of Commerce, will continue studies started last year on the dilution and dispersal of contaminants in the atmosphere. These include the development of techniques for the survey of problem areas, including the nature and variability of the weather processes involved; climatological evaluation of existing weather data to determine air-pollution potentialities; and investigation of methods for predicting weather conditions associated with extreme levels of community air pollution, including the need for development of alert and warning systems. The Public Health Service has allocated $185,500 for these studies for the current year.

The National Bureau of Standards, Department of Commerce, will undertake development of rapid field methods of sampling and analysis for the determination of individual substances in the atmosphere. NBS will also continue to develop methods of sampling, transporting, analyzing, and identifying various gaseous contaminants by instrumental methods; study application to particulate matter of microchemical methods, x-ray diffraction, and spectroscopy; and study reactions that take place in air among hydrocarbons and other constituents of polluted atmosphere. The PHS is providing $125,000 for this work during the year ending next 30 June.

The Interior Department's Bureau of Mines will receive $125,000 to continue its investigation of the causes of inadequate incineration of combustible wastes and the means of improving incineration; to continue its evaluation of sulfur dioxide removal processes; and to continue its evaluation of effects of fuel and lubricant characteristics on the composition of gases exhausted from internal combustion engines.

The Library of Congress last year began preparation of a continuing, annotated bibliography on air pollution,

including references to the physical, biological, engineering, legal-administrative, and economic aspects of atmospheric pollution. To continue this work during the current fiscal year, the Public Health Service has allocated $17,525 to the library.

The Department of Agriculture has agreed to assign personnel to the Public Health Service to conduct studies of plants as air-pollution indicators. For this work, the service will provide for the salaries of two plant scientists, as well as for space and equipment for plant studies related to air pollution, in its Taft Sanitary Engineering Center in Cincinnati, Ohio.

In addition to the agreements noted here, the Surgeon General recently announced the award of 12 grants for air-pollution research by non-Federal institutions, totalling $318,568. Various air-pollution studies also are being conducted within the Service's own facilities and through contracts with non-Governmental research groups.

In the Laboratories

■ The Podbielniak Institute, 632 N. Dearborn St., Chicago, Ill., has been founded by Dr. and Mrs. Walter J. Podbielniak as a self-sustaining but essentially nonprofit institution to make available to industry special instruction and training courses in analysis of gases and vaporizable liquids. The idea for such a training school was first conceived in 1952 at the time that the Natural Gasoline Association of America had completed a series of comparative analytic accuracy surveys. As a result of these studies, a special, 9-month analysts' training school was conducted at the University of Oklahoma. Light hydrocarbon physical constants, conversion, and calculation methods were standardized and improved, and efficient and accurate analytic techniques were evolved.

In order to continue and extend this type of training, the Podbielniak Institute is now offering a 2-week course intended primarily for qualified industry personnel. The course will include instruction in the analysis of natural gas and gasoline, petroleum and its products as produced by refining and petrochemical processes, and similar complex gases and vaporizable liquid mixtures.

■ The Stanford Research Institute, Menlo Park, Calif., will open a European office in Zurich, Switzerland, shortly after 1 Jan. A principal aim of the office will be to establish a two-way flow of information between European and American industrial and research organizations seeking new research, production, or marketing relationships. Another function will be the development of exchange and fellowship programs between U.S. and western European organizations.

Heading the new office will be Robert M. Burns, a senior scientific adviser on SRI's staff since leaving the post of chemical director of Bell Telephone Laboratories 2 years ago. Working closely with Burns will be Lorenzo Franceschini of Milan and Rome, Italy, formerly an official of Italy's National Productivity Committee and a holder of an SRI international research fellowship during 1954–55.

■ A design study and development work to determine the feasibility and economics of heavy water moderated reactors for electric power generation will be undertaken for the Atomic Energy Commission by E. I. duPont de Nemours and Company. The study will pay particular attention to the utilization of natural uranium as fuel.

The work will be performed under the existing contract between the DuPont Company and the commission for the operation of the AEC's Savannah River Plant in South Carolina. DuPont will utilize personnel from both the Savanah River Plant and its main office in Wilmington, Del., in carrying out the study. The commission-DuPont agreement makes no commitment for construction of a power reactor.

Miscellaneous

■ The *Handbook of Biological Data*, in preparation under the direction of a National Academy of Sciences–National Research Council committee for the past 7 years, has just been published. More than 17,000 biologists have participated in the preparation of this work. The handbook committee's basic task was the definition of the volume's scope and of the audience to whom it was to be addressed. It was the committee's decision that the handbook should be abridged and that it should be addressed primarily to scientists who have frequent need for information outside their own area of specialization.

■ The home of Joseph Priestley has been acquired and is being restored to its original appearance by the Borough of Northumberland, Pa. [*Science* **124**, 117 (20 July 1956)]. This house, started in 1795 and completed in 1797 and owned for many years by the Priestley family, was purchased in 1920 by Pennsylvania State University and presented this year (1956) to Northumberland. The home is of Georgian architecture, is in fine condition, and occupies an acre of landscaped ground near the Susquehanna River. Under the direction of the Priestley Memorial Association, the Widow's Walk, kitchen and laboratory are being restored to their original appearance and the rooms refurnished with American furniture in style around 1800.

The association desires to gather all obtainable information on Priestley and on his American home. It would like to receive reprints of articles bearing on his work, and it welcomes correspondence with anyone interested in this matter. Visitors are welcome. Correspondents may address Mr. Lewis K. Rich, 464 Front St., Northumberland, Pa.

The Division of History of Chemistry of the American Chemical Society is cooperating with the Priestley Memorial Association in the restoration of Priestley's laboratory. To this end a committee including Sidney Edelstein, Claude K. Deischer, and Wyndham Miles, chairman, has been constituted. The committee wishes to locate apparatus of Priestley's American period, with a view to acquiring them or having replicas made. It welcomes correspondence with anyone knowing the whereabouts of apparatus, and with scholars interested in this project. Correspondents may address Dr. Wyndham Miles, Edgewood, Md.

■ The International Commission on Zoological Nomenclature has announced that beginning 30 May 1957 it will start voting on the following case involving the possible use of its plenary powers for the purpose specified. Full details were published on 30 Nov. in the *Bulletin of Zoological Nomenclature* (vol. 12, Pt. 11): Pieridae Duponchel, 1832, validation of family-group name (Cl. Insecta, Order Lepidoptera).

In addition, applications for the use of the plenary powers in the following cases will be published on the same date in Pt. 12 of vol. 11 of the above bulletin: (i) *Ptychopyge* Angelin, 1854, designation of type species (Cl. Trilobita); (ii) convexa de Haan, [1835] (Ocypode (Chasmagnathus)) validation (Cl. Crustacea, Order Decapoda). Comments should be sent as soon as possible and in duplicate to the secretary to the commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1, England.

Erratum: On page 925 of the 9 Nov. issue of *Science* we stated that "Nineteen members of the Atomic Energy Commission research project at the University of Rochester Medical Center" endorsed a statement criticizing the President's recent defense of nuclear weapons tests. Actually, only five of the 19 members of the university staff who signed the statement were associated with the AEC project. These five constituted about 10 percent of the project's scientific staff.

Reports

Permeable Spots in the Cuticle of the Thin-Walled Pegs on the Antenna of the Grasshopper

The largest of three types of basiconic sensory pegs which are present on the antennal flagellum of the grasshopper is permeable at its tip to water and to aqueous solutions of dyes when they are applied to the outer surface of the antenna of the living insect (*1*). These large permeable pegs, which are thick-walled except at the tip, are found not only on the antennae but on other parts of the body as well, and experimental evidence indicates that they are probably the receptors which are affected by strong repellent odors (*2, 3*). The two smaller types of basiconic pegs, both of which are thin-walled, occur only on the antennae, and these have resisted many attempts to demonstrate that they, too, are permeable to water and to dyes (*1*).

Recently it has been found that each of these types of thin-walled peg is provided with a minute permeable spot near its base and that this is also the point where the distal processes of the sensory neurones are attached. Because of the small size of these spots, their position at the base of the peg, and their own natural, pale brown color, stain, when it does enter, is not easy to detect. The preparations in which the permeability of these spots was first successfully demonstrated were made with the antennae of the large eastern lubber grasshopper, *Romalea microptera* (Beauvois), which is a particularly useful species for the study of fine histological detail. The antenna was removed from the living insect and placed at once in a petri dish between two small squares of cotton gauze that had been wet with a 0.5-percent solution of methylene blue in Ringer-Locke solution. The cut end of the antenna protruded from between the layers of gauze so that the dye could not reach it. Two hours later, the antenna was cut into several short pieces and fixed in ice-cold 8-percent ammonium molybdate for 12 hours or longer. The pieces were then washed in cold distilled water and divided lengthwise, and the soft tissues were brushed out. After a quick dip in 70-percent alcohol and in absolute alcohol, followed by 10 or 15 minutes in dioxan, the pieces were cleared in toluol and mounted flat and with the outer surface uppermost in Harleco synthetic resin. In such preparations, the large basiconic pegs are stained blue at the tip, while the two smaller types of basiconic pegs each show a single, small, rounded, blue patch near the base. The coeloconic pegs, which are also permeable at their tips, are only rarely colored, for the air that occupies the small cavity in which each lies is usually not displaced by the staining solution, and special means must be used to bring the dye into contact with the tips of these pegs (*3*).

It is now possible to state, for the first time, that each of the four types of sensory pegs—three basiconic and one coeloconic—that are present on the antennal flagellum of the grasshopper is provided with a small specialized region through which water and dyes in aqueous solution pass readily. In the coeloconic peg and in the largest of the basiconic pegs, this specialized area is at the tip, while in the two smaller types of basiconic pegs it is located at the base.

In the past it has been generally assumed and often stated in the literature that the thin-walled sensory pegs of the insect function as chemoreceptors, and there is much experimental evidence to support this view (*4*). It is of particular interest, then, to point out that in the thin-walled basiconic pegs on the antenna of the grasshopper it is not the entire wall that is permeable but only a very small specialized region of it.

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3 October 1956

Does Starvation Increase Sperm Count?

With reference to a recent article on starvation and sperm count (*1*), we wish to make a few comments. It is common knowledge that sperm count in an ejaculate is subjected to great variations in the same individual and among different species (*2*).

When a simple analysis of statistical significance was applied to the data of this article (*1*), it was found that comparisons of differences in each individual dog before starvation, during starvation, and after starvation have P values of about 0.5. Not one case displayed significant differences (P value of 0.01) either when analyzed according to sperm concentration or for total number of sperm. Furthermore, according to the recent determinations of McMillan and Harrison (*3*), the transportation of sperm from testis to the tail of the epididymis probably takes at least 14 days. Thus, if starvation did increase sperm count, it did not reflect sperm production but the evacuation of a large number of sperm from the epididymis. As for the high birth rate of the undernourished in India, many complicating factors may be involved, from the high selection pressure for fertility (*4*) to the lack of radio and television (*5*).

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3. E. W. McMillan and R. G. Harrison, *Nature* 176, 340 (1955).
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5. W. O. Douglas, *Strange Lands and Friendly People* (Harpers, New York, 1951).

5 October 1956

The comments of Chang and Scheaffer are of interest because (i) they point up the controversial nature of the effect of starvation on fertility and (ii) they pose further problems for solution. We are now writing a longer article reviewing the literature, which mostly inclines to the opposite view to ours—that is, that starvation, especially malnutrition, decreases fertility. Observation of mating animals, such as the seal, the penguin, and the salmon shows that even 30-percent loss of weight accompanies sexual activity.

Starvation may have a different effect

in well-nourished animals, such as our dogs, and in the debilitated. Even though the *P* value may indicate *no difference* resulting from starvation, this finding of no difference is of importance and against current opinion. The notation of Chang and Scheaffer of the length of time for the transportation of spermatozoa—beyond the period of starvation—poses another problem, that of the mechanism of the effect of starvation. Chang and Schaeffer emphasize the need for knowledge and the lack of clarity in this unsettled problem.

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7 November 1956

Rigidity of the Earth's Core

The rigidity of the earth's core is significantly less than that of the mantle. This is confirmed by the apparent absence on earthquake seismograms of shear waves that have traversed the core. Additional evidence cited by Honda et al. (*1*) is based on the amplitude of earthquake-generated shear waves reflected from the core (*ScS*) relative to the amplitude of direct-arriving shear waves (*S*). Since some assumptions concerning the radiation pattern of shear waves from an earthquake focus must be made, the latter method is useful for order of magnitude determinations only.

A quantitative estimate of the rigidity of the core may be obtained by a difficult computation involving the known rigidity of the mantle and the data for bodily tides and pole movements. Takeuchi (*2*) found a maximum value of core rigidity of 10^9 to 10^{10} dyne/cm² by this method. More recently, Molodenskiy (*3*) gives $\frac{1}{2} \times 10^{12}$ dyne/cm².

In this paper (*4*) the rigidity of the core is determined from the amplitude ratio of twice reflected shear waves, ScS_{II} to once reflected waves ScS_I under conditions of near vertical incidence. This procedure minimizes the number of

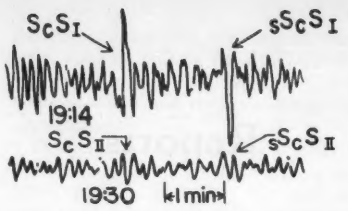

Fig. 1. Core phases from the earthquake of 22 December 1940.

assumptions required to interpret the data. Five occurrences of $ScS_{I,\ II}$ pairs suitable for amplitude-ratio determinations were found on Huancayo seismograms of near earthquakes with intermediate focal depths (see Table 1). The identification of these phases is made certain by the presence of their surface images $sScS_{I,\ II}$ (see Fig. 1).

To interpret the amplitude-ratio data, we use the approximate relationship

$$ScS_{II}/ScS_I = [Rc \exp(-2\sigma d)]/2 \quad (1)$$

where σ is the average absorption coefficient for shear waves in the mantle, d is the depth of the core, and Rc is the reflection coefficient for shear waves vertically incident on the mantle-core interface. The dimensionless dissipation parameter $1/Q$ is related to σ by $1/Q = \beta T\sigma/\pi$, where β and T are the velocity and period of shear waves, respectively. Rc is given by

$$Rc = [(\mu_m\rho_m)^{1/2} - (\mu_c\rho_c)^{1/2}][(\mu_m\rho_m)^{1/2} + (\mu_c\rho_c)^{1/2}]^{-1} \quad (2)$$

where μ and ρ are rigidity and density respectively, and the subscripts m and c refer to mantle and core in the neighborhood of the boundary. Implicit in the use of Eq. 1 are the assumptions that spherical divergence and the plane-wave, steady-state reflection coefficient are applicable. Since the wavelengths and focal depths are small compared with the radii of curvature of the boundaries, these assumptions are reasonable. They are partially validated by the identical amplitudes of *ScS* and its surface image *sScS* as shown in Fig. 1. The mean ratio of ScS_{II}/ScS_I for five earthquakes was 0.3. As indicated by Eq. 1, this decrease in amplitude may be ascribed both to absorption of the shear waves in traversing the mantle and to loss on reflection from the core boundary. On the assumption of a perfectly elastic mantle in which $\sigma = 0$, Eqs. 1 and 2 yield a maximum value of core rigidity: $\mu_c < \mu_m\rho_m/16\rho_c$. Using $\rho_m/\rho_c \sim 4/7$ and $\mu_m = 3 \times 10^{12}$ dyne/cm² (*5*), we find $\mu_c < \mu_m/30 \sim 10^{11}$ dyne/cm². Assuming a vanishing rigidity in the core, and taking $T = 11$ sec. and $\beta = 6.2$ km/sec, we find that the maximum value for the average dissipation constant in the mantle is $1/Q \sim 200 \times 10^{-5}$. This is sufficiently close to values of $1/Q$ found by other methods (*6*) to indicate a rigidity in the core between zero and at least an order of magnitude smaller than 10^{11} dyne/cm². Since the incompressibility in the core is of the order of 10^{13} dyne/cm², the ratio of rigidity to incompressibility is smaller than 10^{-3}, indicating a state unlike that of a normal solid.

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Table 1. Huancayo observations of amplitude ratio ScS_{II}/ScS_I. The average amplitude ratio is 0.29.

Earthquake date	Origin time (hr:min:sec)	Distance (deg)	Focal depth (km)	Magnitude	Amplitude ratio
6 May 1936	03:38:55	4	160	6	0.25
16 Feb. 1943	07:28:35	4	190	7	0.42
26 Feb. 1952	11:31:00	5	260	7	0.25
19 Sept. 1935	09:55:47	7	250	6½	0.29
22 Dec. 1940	18:59:46	8	230	7	0.25

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24 September 1956

Effect of a Severe Storm on Electric Properties of a Tree and the Earth

For more than a decade, virtually continuous measurements have been made of the relatively steady-state standing potential of a tree. The potential difference is determined between two reversible, nonpolarizable silver-silver chloride electrodes imbedded in the cambium in the long axis of the tree, and separated by about 3 feet. These potentials show diurnal, monthly, and seasonal variations of considerable interest and, over the years, a suggestion of a correlation with sunspot activity.

It seemed worthwhile, therefore, to begin the study of the electric environment of the tree as measured by earth and atmospheric potentials recorded simultaneously with the potentials of the tree in order to determine the possibility of an interrelationship.

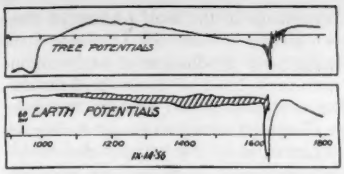

Fig. 1. Tree and earth potentials (millivolts) during a severe storm (Eastern Standard Time). The potential difference above the base line is positive for the upper electrode in the tree and for the south electrode in the earth.

A test run on earth potentials was started last summer, using exactly the same technique as was used in the tree, with silver-silver chloride electrodes buried in the moist earth, high-impedance input amplifiers, and photoelectric recorders. It is thus possible to obtain continuous and simultaneous records of the changing potentials.

On Friday, 14 Sept. 1956, between 4 and 6 P.M., Lyme, Conn., as well as many other New England areas, was hit by a severe squall. Very high winds and torrential rain, lasting for roughly half an hour, were observed. Examination of the photoelectric records from both the tree and the earth showed the rather remarkable phenomenon shown in Fig. 1. In the tree, the upper of the two electrodes was positive 40 or 50 mv, and in the ground the south electrode on the north-south axis was positive about 60 mv for several hours before the onset of the storm.

Prior to the onset of the storm, there was, for 4 or 5 hours in the earth record, an oscillation of the standing potential, the 10-mv envelope of which appears in Fig. 1 (cross-hatching). Then, quite suddenly, the positive potential of the south electrode dropped to zero and became the negative potential of 20 or 30 mv. As the storm passed, this excursion was reversed, and the relatively steady-state standing potential reappeared as a positive potential of 60 mv. During the succeeding 3 or 4 hours, the magnitude of this potential decreased to that characteristic of the early hours of the day.

A very similar change occurred in the tree potentials prior to the storm, with the development of a reversed polarity paralleling that in the earth, beginning somewhat sooner, and taking a little longer to develop.

Since this is a pilot experiment, no interpretation can be made at this time, but it is hoped to continue these studies, including not only north-south potentials in the earth, but also east-west potentials. As soon as funds are available with which to install the necessary equipment, atmospheric potentials will also be recorded simultaneously. Since it has been adequately demonstrated that a living organism, the tree, is an electric system exhibiting all the properties of an electric field, one may reasonably expect that changes in the electric environment will show some interrelationship with the field properties of the tree. Over many years, for example, thunderstorms have shown characteristic changes in the standing potential of the tree. Sharp spikes appear in the tree record during the storm. It should be noted that corresponding spikes did not occur in the earth record. Adequate controls have shown that these are not instrumental artifacts caused by interference in the power supply. Instead, they are evidence of very considerable changes in the tree potential associated with the very profound changes in earth and atmospheric electricity.

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Isolation of a Cardiac-Active Principle from Mammalian Tissues

It is known that the isolated mammalian heart, even though it is maintained under physiological conditions, gradually loses contractile force. This failure, which in many respects resembles chronic congestive heart failure, can be reversed by digitalis. It can also be overcome by inclusion of the liver in the circulatory pathway of the mammalian heart lung preparation (*1*). Failure of the isolated frog heart that has been induced by perfusion with Ringer's solution can be reversed by addition of mammalian serum to the heart (*2*, *3*). These observations have suggested the possible presence in mammalian tissues of material that resembles digitalis in its physiological effects (*1*, *3*).

A search was undertaken for the active principles in mammalian tissue, using a bioassay based on the staircase phenomenon in the frog heart (*4*). Deproteinized acetone extracts of tissue were defatted with petroleum ether, and the active material was fractionated by chromatography on Florisil. The most abundant source examined was beef adrenal medulla, which contained activity equivalent to 1000 μg of strophanthidin per kilogram; others were beef liver, 200 μg/kg and plasma, 180 μg/kg. Little or no activity was found in adrenal cortex, red blood cells, or skeletal muscle.

The active component has been crystallized from extracts of adrenal tissue and identified as monopalmitoyl glycerylphosphorylcholine (palmitoyl lysolecithin). On a molar basis, this material had 1/60 the activity of strophanthidin, 1/40 the activity of digitoxin and one-third that of digitoxigenin. Several lysolecithins prepared synthetically (*5*) have also been shown to have activity qualitatively similar to that of digitalis on the frog heart.

In addition to the known hemolytic activity of lysolecithin, the following biological effects of the isolated material have been observed. It increases the tension of the hypodynamic frog heart, abolishes the staircase phenomenon in the frog heart, increases the tension of the isolated squab ventricular muscle, and causes contracture of the isolated carotid artery strip. In all these respects, the action of digitalis is similar. Furthermore, this lysolecithin resembles the glycosides by virtue of its strong affinity for the heart, a quality not shared by other substances, such as the catecholamines and certain cortical steroids that have also been shown to be cardiotonic in the frog heart (*3*).

Although the isolated material appeared to be chemically pure, it exerted two biological effects; (i) the characteristic digitalis-like action on the staircase and (ii) a toxic activity resembling that of the saponins and characterized by rapid onset of contracture. The former effect was found to be associated with β-lysolecithin, while the toxic factor was identified as an isomer arising by intramolecular rearrangement of the ester bond to the α-carbon of the glycerol. The toxic substance appears to be an artifact formed during isolation. It may be destroyed by hydrolysis with the phospholipase A of *Crotalus adamenteus* venom.

Approximately 50 percent of the active substance in the adrenal medulla and 80 percent or more of that in liver and serum occurs in the form of an inactive precursor, which is somewhat more lipoid soluble than the lysolecithin and from which the latter is liberated on standing for a few hours at *p*H 2. This precursor appears to be a hemiacetal derivative of the lysolecithin with a long-chain fatty aldehyde. A substance of this structure has been identified in heart muscle by Klenk and Debuch (*6*).

What role palmitoyl lysolecithin might play in normal mammalian physiology cannot be decided on the basis of tests in the frog heart. If the mechanism by which it acts on the staircase phenomenon in this heart is the same as that of the cardiac glycosides, it would appear to serve as a regulator of membrane permeability to potassium (*4*).

The hemiacetal precursor might serve as a nonhemolytic form in which lyso-

lecithin could be transported to a site of action for release by liberation of the aldehyde. Whether such a site of action would be the heart or some other organ or organs cannot yet be decided. These questions are being investigated further.

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27 September 1956

Evidence for Nonexistence of D-Aspartic Acid in Casein

The values reported previously for L-aspartic acid and total (L + D) aspartic acid in acid hydrolyzed casein (*1*) imply that the aspartic acid in this material was approximately 7 percent racemic (*2*). The question of whether racemization to this extent is a consequence of the hydrolysis procedure or whether D-aspartic acid residues are initially present in intact casein was left unsettled but appears now to be resolved by the results of the present experiments (*3*).

Samples (3 g each) of casein (*4*) were heated with 30-ml portions of 6*N* hydrochloric acid under reflux for varying periods of time, and each hydrolyzate was assayed for L-aspartic acid and for total aspartic acid by the previously described methods (*1*). The L-aspartic acid values (*5*) found after heating for 29, 32, 340, 550, and 720 hours, respectively, were 6.65, 6.92, 4.52, 4.00, and 3.77 percent, whereas the corresponding total aspartic acid values (*5*) averaged 7.21 (7.20, 7.31, 7.15, 7.20, 7.17) percent. Corresponding values for nonracemic aspartic acid (*6*) in each hydrolyzate were calculated from these data, and the logarithms of the resulting values were plotted against time (Fig. 1), revealing the linear relationship that would be expected for racemization at a constant rate. The straight line shown in Fig. 1 is that fitting the data most closely according to the theory of least squares. It extrapolates at zero time to a value corresponding to 7.37 percent nonracemic aspartic acid, a value that agrees within experimental error with the mean value for total aspartic acid

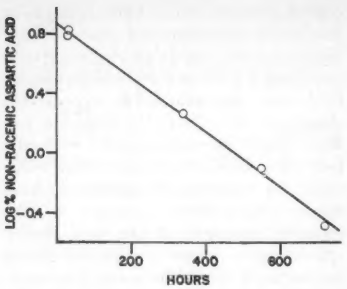

Fig. 1. Nonracemic aspartic acid in casein hydrolyzate as a function of refluxing time.

(7.21 percent). It appears, therefore, that none of the aspartic acid in casein is initially racemic and that racemization of the aspartic acid in casein proceeds essentially at the same rate before and after liberation by acid hydrolysis.

Interpolation on the curve shown in Fig. 1 indicates that the aspartic acid in mixtures of casein and 6*N* hydrochloric acid is 4.1, 8.0, and 11.8 percent racemic, respectively, after 10, 20, and 30 hours of heating the mixtures under reflux.

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3. This investigation (No. 115) was aided by grants from the Eli Lilly Company, the Nutrition Foundation, Swift and Company, the National Multiple Sclerosis Society, and the University of California. We are indebted to Evelyn Brown and Arthur Yuwiler for technical assistance.
4. Prepared by L. E. McClure essentially according to the procedure described by Dunn *et al.* [*J. Biol. Chem.* 155, 591 (1944)]. The product contained 14.13 percent nitrogen, 10.19 percent moisture, and 1.66 percent ash.
5. Calculated as percentage of moisture and ash-free material.
6. The differences between 7.21 (the mean total aspartic acid value) and twice the L-aspartic acid values.

27 September 1956

Interaction of Hormonal Effects: Influence of Triiodothyronine on Androgen Metabolism

It has been found (*1*) that triiodothyronine can markedly alter the relative proportion of urinary androsterone and etiocholanolone produced from endogenous or exogenous precursors without any change in the total amount of these two steroid metabolites. In Table 1 the endogenous production of androsterone and etiocholanolone in two patients during a control period without treatment is compared with that found during administration of 200 μg per day of triiodothyronine. It is evident that the thyroid hormone caused an increase in the amount of androsterone with a concomitant fall in the amount of etiocholanolone. Examination of an untreated myxedematous patient showed that etiocholanolone in the urine was 7 times higher than androsterone, despite a low level of production of these metabolites.

With this evidence that elevation of thyroid hormone increased the formation of androsterone, while a diminished thyroid secretion favored the production of etiocholanolone, it was desirable to study the influence of triiodothyronine on the metabolic products produced from

Table 1. Change in proportion of endogenous steroid metabolites with triiodothyronine. Subject P, surgical diagnosis of Stein-Leventhal syndrome; subject F, multiple sclerosis, steroid production and metabolism normal in all respects, from repeated studies in these laboratories. The dose of triiodothyronine was 200 μg per day for a period of 7 (P) and 9 days (F) prior to the studies. The methods used for steroid isolation and analysis have been described (*3*).

Subject	Treatment	Androsterone (mg/24 hr)	Etiocholanolone (mg/24 hr)
P – ♀	Control	3.8	3.9
	T – 3	5.3	2.3
F – ♂	Control	2.2	3.3
	T – 3	3.1	2.7

Table 2. Change in proprotion of metabolites of testosterone-4-C^{14} with triiodothyronine. Subject F, see Table 1; subject M, multiple sclerosis, otherwise in good health.

Subject	Treatment	Androsterone (%)*	Etiocholanolone (%)*
F – ♂	Control	37	44
	T – 3	53	29
M – ♀	Control	21	59
	T – 3	59	29

* Percentage recovered of the total radioactivity in the neutral steroid fraction of the urine, first 24 hours after hormone injection, after hydrolysis of conjugates with β-glucuronidase (Ketodase). The amount of each steroid present was measured by addition of weighed amounts of carrier, purification to radiochemical homogeneity, and calculation from the total radioactivity present in the extract and in the pure steroid. Details of isolation, purification, and measurement were essentially similar to those previously described (*2*).

testosterone-4-C^{14}. It is well known that androsterone and etiocholanolone are the major and nearly exclusive end products of this hormone (*2*).

Tracer amounts of radioactive testosterone were given intravenously in saline solution over a period of 30 minutes to a male and a female subject during a control pretreatment period and 10 days later while they were under treatment with 200 μg per day of triiodothyronine. The results, shown in Table 2, demonstrate that the metabolism of exogenous hormone was altered in the same direction as that observed with endogenous precursors. This effect, similarly, was achieved without any essential change in the total amount of the two metabolites recovered from the testosterone injected.

It can be concluded from these experiments that a thyroid hormone markedly influences the metabolism of androgen from endocrine glands as well as that artificially introduced into the body. The significance of these observations, as well as the details of the study and its extensions, will be described in subsequent reports (*4*).

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References and Notes

1. This investigation was supported by a grant from the American Cancer Society, and by a research grant (C-440) from the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. The initial observation with subject P was made in collaboration with Rulon W. Rawson, division of clinical investigation, Sloan-Kettering Institute, to whom we express our thanks for his cooperation.
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10 October 1956

Formation of UDPGla and Related Compounds by the Soluble Fraction of Liver

In a recent publication (*1*), it was reported that, although an extract of rat liver nuclei formed UDPG (*2*) and UDPGla from UTP and glucose-1-phosphate and glucosamine-1-phosphate, respectively, the formation of UDPAG from UTP and N-acetyl glucosamine-1-phosphate could not be demonstrated. This result was unexpected, since the pyrophosphorolysis of UDPAG by rat liver nuclei described by Smith and Mills (*3*) should be reversible. It thus seems likely that UDPG and UDPAG are synthesized by separate enzymes and that our preparations of nuclear extract were devoid of the second enzyme.

Studies were, therefore, conducted to determine whether the system that forms UDPAG was present in other fractions of the cell (*4*). The best results were obtained with the supernatant fraction of rat-liver homogenate. The protein-free reaction mixtures were chromatographed by a gradient-elution method similar to that described by Hurlbert *et al.* (*5*), and the nucleotides were determined by their light absorption at appropriate wavelengths.

Preliminary studies indicated that when UTP had been incubated in the presence of the soluble fraction of rat liver, a peak corresponding to UDPG appeared. This probably resulted from the breakdown of glycogen to glucose-1-phosphate, which then reacted with UTP to form UDPG. When synthetic N-acetyl glucosamine-1-phosphate (*1*) was added to the supernatant in addition to UTP, the UDPG peak appeared to overlap with that of another uridine-containing nucleotide. These combined peaks were lyophilized and hydrolyzed in 0.01*N* HCl for 30 minutes. The presence of N-acetyl glucosamine in the hydrolyzate was revealed by the method of Reissig *et al.* (*6*). Glucose was shown to be present by a micro method involving the use of glucose oxidase, which does not react with either glucosamine or N-acetyl glucosamine.

Better separation of the nucleotide components was achieved with the solvent combinations described in Fig. 1. A control or zero time sample has been omitted, for the nucleotides in the supernatant fraction of rat liver and in the UTP were found to be negligible in quantity. The contention that glucose-1-phosphate was present in the liver supernatant fraction or resulted from glycogen breakdown is supported by the enhanced formation of UDPG upon the addition of glucose-1-phosphate (compare *A* and *B*, Fig. 1). The higher concentration of UMP in *B* as compared with that in the other experiments is explained by the finding that the liver fraction rapidly breaks down UDPG to uridine, UMP, and UDP.

The synthesis of UDPAG from UTP and N-acetyl glucosamine-1-phosphate is shown in Fig. 1*C*. UTP is probably the primary nucleotide in the conversion, for, though UDP was found to support the synthesis of UDPAG, it was less effective than UTP. UDP is probably active only as a result of its conversion to UTP by a myokinase-type reaction (*7*). A transferase reaction between N-acetyl glucosamine-1-phosphate and UDPG has not been entirely eliminated, but so far we have been unable to obtain evidence for the existence of this reaction. Fig. 1*D* reveals the formation of UDPGla from UTP and glucosamine-1-phosphate as described previously for rat

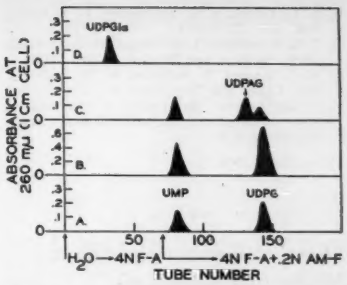

Fig. 1. The reaction mixture in each experiment contained 1 ml of a 20-percent rat-liver homogenate prepared in 0.15*M* KCl and centrifuged (20,000*g*) for 30 minutes to remove the particulate components; 0.08*M* tris-hydroxymethylaminomethane buffer at *p*H 7.6; 0.01*M* KF; 0.006*M* $MgCl_2$; and 0.008*M* UTP. The added substrates were as follows: (*A*) none; (*B*) 0.008*M* glucose-1-phosphate; (*C*) 0.008*M* N-acetyl glucosamine-1-phosphate; and (*D*) 0.008*M* glucosamine-1-phosphate. The total volume in each case was 2.5 ml, and the incubation time was 15 minutes at 30°C. The reaction was stopped by the addition of 1 ml of 10-percent trichloroacetic acid. The protein was removed by centrifuging and, after neutralization, the soluble portion was placed on a 20- by 1.2-cm Dowex-1 formate column. The mixing chamber contained 250 ml of H_2O initially, and 5-ml fractions were collected in each tube.

liver nuclei (*1*). The chromatogram in this experiment was not extended farther than the elution of the UDPGla peak. This nucleotide has not yet been found as a naturally occurring physiological substance, but its possible occurrence cannot be ignored.

Our finding that the conversion of UTP to UDPG is much more rapid than is conversion to UDPAG is consistent with the finding of Brumm, Sicekevitz and Potter (*8*) that liver homogenate incorporates phosphorus-32 into UDPG more rapidly than into UDPAG.

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24 September 1956

Effects of Fluorocompounds on Mechanisms Related to Mitochondrial Phosphate Transfer

While studying oxidative phosphorylation in rat liver mitochondria (*1*), we have found that the P/O ratio of such preparations is markedly lowered on addition of fluoroacetate to the system (Table 1) (*2*). The effect of this compound on the adenosine triphosphate (ATP) that is formed can be seen before any appreciable inhibition of oxygen consumption is observed, supporting the belief that processes regulating phosphate transfer have a higher sensitivity to the fluorocompound than do the respiratory steps associated with the phosphorylation. In view of these findings, the conclusion (*3*) that fluoroacetate has no effect on oxidative phosphorylation cannot be supported.

Since other experiments showed that the hexokinase used to "trap" the ATP was not affected by fluoroacetate, fluorocitrate, or fluoropyruvate, the lowered P/O ratio could be due to the effect of the fluorocompound on the synthesis of ATP or to an accelerated dephosphorylation of the ATP after it was formed. Attempts to show an effect on the synthesis of ATP by using the mitochondrial extract described by Lehninger (*4*) have been complicated by the attendant ATPase activity of the preparations, although it was shown that fluoroacetate decreases the net incorporation of P^{32} into ATP in the reaction

$$ADP + P^{32} \rightarrow ATP^{32}$$

In vivo experiments (*5*) have shown a small but significant decrease in labile nucleotide phosphorus in the brain following injection of fluoroacetate, and on comparing the effects of fluoroacetate, fluorocitrate, fluoropyruvate, and 2–4 dinitrophenol (DNP) on the release of phosphate from adenosine monophosphate (AMP), adenosine diphosphate (ADP), and ATP by liver mitochondria, we observed (Table 2) that the dephosphorylation of all three nucleotides was stimulated. Fluorocitrate was by far the most active of the fluorocompounds, showing stimulation even at $10^{-6}M$, while fluoroacetate was only slightly active. Interestingly, DNP and the fluorocompounds at very low concentrations produced consistently lower hydrolysis of the nucleotides than did the controls. It is of significance that, whereas the greatest stimulation of phosphate release by the fluorocompounds is seen when AMP is the substrate, the stimulation of dephosphorylation produced by DNP is greatest when ATP is used. Since the mitochondria are capable of rapid interconversion of these three nucleotides, as demonstrated chromatographically, the reactions undergone by a given nucleotide are numerous, and studies on the time-courses of these interconversions in the presence and absence of the fluorocompounds are currently under investigation in an attempt to identify the site(s) of action of these compounds.

That a certain degree of structural integrity of the mitochondria is necessary for these effects is demonstrated by experiments in which the mitochondria have been "pre-aged" by the method of Lardy (*6*): under these conditions, the ability of the fluorocompounds and of DNP to stimulate the dephosphorylation of the nucleotides is greatly diminished. Hunter (*7*) has shown that DNP has no action on the partially purified ATPase of potato, and we have now demonstrated that the soluble 5′-nucleotidase of rattlesnake venom (*8*) is affected by neither DNP nor fluoroacetate nor fluorocitrate.

It does not appear that the fluorocompounds exert their effects by combining with some metal within the mitochondria, for the addition of equivalent concentrations of Versene has no effect on the dephosphorylating activity of the mitochondria. Furthermore, it was found that oxalic acid ($3.7 \times 10^{-5}M$) suppresses mitochondrial ATPase.

We have found that *p*-chloromercuribenzoate (PCMB) and iodoacetate stimulate dephosphorylation of these nucleotides, iodoacetate being much less active than fluoropyruvate. This finding is of particular interest now, in view of the recently demonstrated interaction between fluoropyruvate and sulfhydryl compounds in a model system (*9*).

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Table 1. Effect of fluoroacetate on oxidative phosphorylation. The flasks contained the following: 0.02*M* tris buffer at *p*H 7.28; 6 μmole of $MgCl_2$; 120 μmole of KCl; 20 μmole of potassium fumarate; 25 μmole of KF; 0.5 μmole of ATP; 40 μmole of potassium phosphate; 1 ml of rat liver mitochondria in 0.25*M* sucrose; 744 μmole of sucrose; 30 μmole of glucose; and 0.5 mg of hexokinase added from a side arm, with a final volume of 3 ml. The contents were incubated for 15 minutes at 37°C in oxygen. The reaction was stopped by 0.5 ml of 20-percent trichloroacetic acid.

Item	Oxygen (μatoms)	Phosphate (μmole)	P/O
Control	2.58	6.39	2.48
Fluoroacetate ($3.3 \times 10^{-3}M$)	2.55	3.81	1.49

Table 2. Comparative effects on nucleotide hydrolysis. The flasks contained the following: 10 μmole of nucleotide freshly neutralized to *p*H 7.28; 744 μmole of sucrose; 6 μmole of $MgCl_2$; 120 μmole of KCl; 0.02*M* tris buffer at *p*H 7.28; and mitochondria (from approximately 300 mg of rat liver) in 0.25*M* sucrose. The final volume was 3 ml. The contents were incubated for 20 minutes at 30°C in a Dubnoff shaking incubator. Phosphate was determined by the method of Gomori (*10*). The values given have been corrected for endogenous phosphate. The figures in parentheses indicate percentage stimulation above the respective controls.

System	Phosphate (μmole) released from		
	AMP	ADP	ATP
Control	1.59	3.31	5.85
DNP ($10^{-5}M$)	2.37 (48%)	7.91 (138%)	14.16 (142%)
Control	1.19	3.76	5.99
Fluoroacetate ($10^{-3}M$)	0.97 (−19%)	4.34 (15%)	6.05 (0)
Control	0.88	2.22	4.31
Fluorocitrate ($1.3 \times 10^{-5}M$)	1.77 (100%)	3.80 (70%)	6.34 (47%)
Control	0.71	1.65	4.40
Fluoropyruvate ($10^{-4}M$)	1.31 (84%)	2.94 (73%)	5.60 (27%)
Control	1.48	3.28	5.94
Iodoacetate ($10^{-4}M$)	2.00 (35%)	4.14 (26%)	6.56 (5%)
PCMB ($10^{-4}M$)	2.57 (73%)	5.71 (74%)	9.28 (56%)

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24 September 1956

Removal of Phosphorus from Hydrogen Peroxide by Kaolinite

Hydrogen peroxide has been used as an oxidizing agent in the determination of organic phosphorus in soils and also in the determination of phosphorus in a solution that contains interfering organic matter, such as the dithionite-citrate extraction of iron phosphate by Chang and Jackson (*1*). Hydrogen peroxide is often highly contaminated with phosphorus, for phosphoric acid is usually added as stabilizing agent. Merck chemically pure 30-percent Superoxol has a maximum PO_4 content of 0.005 percent, which is equivalent to about 16.3 ppm of phosphorus. Therefore it is necessary to remove the phosphorus from the hydrogen peroxide before it is used for the aforementioned determinations. It has been found that the phosphorus could be brought to a satisfactorily low concentration by adsorption on kaolinite (Tables 1, 2, and 3).

Dickman and DeTurk (*2*) used distillation to free hydrogen peroxide from phosphorus. This method requires a comparatively complicated set-up, constant care, and a longer period of time than the new method. Furthermore, the product obtained is only half of the original amount, and the concentration of the hydrogen peroxide is also considerably decreased.

Dickman and Bray (*3*) recommended treatment with $FeCl_3$ and $CaCO_3$ for removal of phosphorus from hydrogen peroxide. They claimed that colorimetric analysis of 5 ml of hydrogen peroxide showed 0.2 ppm of phosphorus. Since $FeCl_3$ causes vigorous decomposition of the peroxide, this procedure is not easily carried out successfully.

In the proposed procedure, 10 g of Merck's "colloid kaolin" (mainly kaolinite) is shaken by hand in 100 ml of hydrogen peroxide for 5 minutes. The suspension is allowed to stand for 1 minute and then is decanted through a Büchner funnel under gentle suction. The filtrate is again treated with kaolinite as before. The number of treatments depends on the original phosphorus content of the peroxide. Three or four (rarely five) treatments are sufficient to reduce the phorphorus content to about 0.1 to 0.2 ppm. It is not necessary to make the first and second filtrates clear. The final filtrate is made clear by centrifugation. Then 0.5 ml of concentrated HCl is added to every 100 ml of the clear hydrogen peroxide for stabilization.

Table 1. Removal of phosphorus from hydrogen peroxide by different amounts of kaolinite.

Kaolin (g/10 ml of H_2O_2)	Resulting concn. of P (ppm)	
	Replication 1	Replication 2
0	6.5	6.5
0.5	3.35	3.4
1.0	1.9	1.9
2.0	1.65	

Table 2. Removal of phosphorus from hydrogen peroxide by successive treatments with kaolinite.

Treatment No.	Resulting concn. of P (ppm)			
	1 g kaolinite per 10 ml H_2O_2		0.5 g kaolinite per 10 ml H_2O_2	
	Replication 1	Replication 2	Replication 1	Replication 2
0	6.5	6.5	6.5	6.5
1	1.9	1.9	3.35	3.4
2	0.2	0.2	1.58	
3	0.12	0.12	0.50	0.5
4			0.12	0.12

Table 3. Volume recovery of hydrogen peroxide, phosphorus concentration, and hydrogen peroxide concentration after three treatments with kaolinite at a rate of 10 g of kaolinite per 100 ml of hydrogen peroxide. The percentage of hydrogen peroxide was determined by titration with standard 0.1*N* $KMnO_4$ according to Treadwell and Hall (*4*).

Time	Total volume (ml)	P content (ppm)	H_2O_2 (%)
Before treatment	500	6.5	28.5
After treatment	430	0.11	26.1

The proposed procedure has the advantages of (i) being simple, (ii) being time saving, (iii) being able to reduce phosphorus to about 0.1 to 0.2 ppm, (iv) giving a high percentage of volume recovery, and (v) giving little loss of H_2O_2 concentration.

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8 October 1956

Relationship between Membrane Potentials and Repolarization in the Rat Atrium

The variation in membrane potentials observed between cell penetrations in a single rat atrium might be interpreted as arising experimentally; on the other hand, such variation may indicate true differences between atrial cells. An inverse relationship between the magnitude and duration of the action potential in the normal atrium was observed.

This correlation was studied quantitatively in 25 atria, from each of which 70 to 80 readings were obtained, by tabulating durations and overshoots of the action potential for 5-mv ranges in the action-potential magnitude (*1*). Membrane potentials were determined with microelectrodes on atria that were stimulated electrically at a rate of 200 per minute as previously described (*2*). The results for 1866 atrial cell penetrations are shown in Table 1. The greater the magnitude of the action potential, the shorter is the duration, and this inverse relationship is linear over the entire range studied. The overshoot varied relatively little and was constant above an action potential of 75 mv.

It might be expected that the lower the action potential, the shorter would be the duration, assuming a constant rate of repolarization; however, just the opposite was observed. The repolarization rate was approximately five-fold greater for the highest action potentials than for the lowest. Since the overshoot was relatively constant over the range, contrary to that of Purkinje fibers (*3*), and since the entire atrial preparation was depolarized during each impulse, it would appear that the repolarization rate is independent of the degree of change from

Table 1. Variations in the membrane characteristics of atrial cells. The repolarization rate was calculated on the basis of a linear repolarization with values obtained from a plot of the data in the table.

Average action potential (mv)	Overshoot (mv)	Average resting potential (mv)	Duration of action potential (msec)	Repolarization rate (v/sec)
53	8.0	45.0	67.5	0.49
58	8.9	49.1	60.1	0.61
63	9.8	53.2	54.0	0.73
68	10.3	57.7	52.6	0.88
73	12.3	60.7	49.5	1.05
78	13.6	64.4	47.3	1.25
83	13.6	69.4	40.4	1.49
88	13.9	74.1	39.1	1.77
93	13.6	79.4	36.2	2.13
98	13.5	84.5	29.3	2.58

the resting potential or of the electric fields arising from adjacent polarized cells. Relative degrees of damage to cells is an unlikely explanation of the variations because of the typical bell-shaped distribution of the values and the constancy of these characteristics over several hours.

The possibility remains that the correlation observed is an expression of some basic difference between the cells. If the rate of repolarization is dependent on K^+ outflow following depolarization, and if this outflow rate is determined by the concentration gradient of K^+ inside and outside the cells, it might be assumed that a rapid repolarization is indicative of a high gradient—that is, a high internal concentration of K^+. If this is correct, cells with the highest repolarization rate should possess the highest resting potentials and, since the overshoot is relatively constant, the highest action potentials, and this is what was observed. It is possible to test this hypothesis using the simplest assumptions. If the rate of K^+ outflow is directly proportional to the concentration gradient, and if the major portion of the repolarization is linear, the repolarization rates for two groups of cells with different potentials would be proportional to the internal K^+ concentrations:

$$\left(\frac{AP-20}{APD}\right)_1 \Big/ \left(\frac{AP-20}{APD}\right)_2 = \frac{(K_i^+)_1}{(K_i^+)_2}$$

where AP is the magnitude of the action potential, $(AP-20)$ is the potential change during repolarization to the level at which the duration was measured, and APD is the duration of the action potential. Using values from a plot of the data in Table 1, and taking the lowest and highest average action potentials in the range studied, the following result is obtained:

$$RP_1 - RP_2 = 59.9 \log \frac{(K_i^+)_1}{(K_i^+)_2} =$$
$$59.9 \log 5.24 = 43.1 \text{ mv}$$

where RP is the resting potential. The actual difference in resting potential (Table 1) is 39.5 mv. Considering that the repolarization is not strictly linear but frequently deviates toward a logarithmic path (*2*) the agreement between the measured and calculated resting potential differences is satisfactory. This agreement does not, of course, prove the hypothesis, but no other reasonable explanation for the data is evident.

Certain implications of importance arise if this hypothesis is correct. Atrial cells would then not constitute a uniform population but a collection of cells with different membrane properties; whether this might reflect functional specialization is a matter of speculation, but the bearing on cardiac arrhythmias, ectopic centers, and abnormal conduction pathways is evident. Such differences would also imply quantitative differences in ion-transport activity or in other factors controlling the accumulation within cells of K^+. Finally, it would support the concept that repolarization is a passive phenomenon in terms of ionic flow, a simple diffusion dependent on concentration gradients and on the permeability properties of the membrane.

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3 October 1956

Book Reviews

Numerical Analysis. Proceedings of Symposia in Applied Mathematics, vol. VI. John H. Curtiss, Ed. McGraw-Hill, New York, 1956. 303 pp. $9.75.

The sixth Symposium in Applied Mathematics of the American Mathematical Society, which was cosponsored by the National Bureau of Standards, took place in Santa Monica in 1953. The delay in publication of the proceedings has not prevented this book from getting on the way to be a best-seller—a second printing was in progress before the book reached me.

Four general points are worth noting. Despite the adjective *applied*, most of the 19 papers included are written by recognized pure mathematicians. Many are genuinely concerned with actual numbers, and only a few are rather out of place. New branches of applied mathematics, for instance, those arising in economic contexts, are well represented. As the editor says in his preface, primary credit for the achievement of interesting so many competent mathematicians in the theory and art of computing must be given to the postwar federal program for the support of science.

Naturally the character of the contributions is variable. There are several research papers, some of which make really notable contributions. There are also reports on the current status of particular problems, or areas of problems, some of which are theoretical, and some practical. Among the topics discussed are systems of linear equations, partial differential equations, conformal mapping, integral equations, elementary, algebraic, and analytic number theory and combinatorial problems (such as occur in the study of geometric configurations). There are also papers on dynamic programming and on the assignment problem, on gas dynamics, and on topics in the theory of approximation, asymptotics, and the calculus of variations.

There is much of permanent value in this volume for the practicing numerical analyst. Apart from this, the volume should do much to reveal the attractions of problems in this field to those mathematicians who are not yet in contact with it. It should also reveal to those responsible for computer organizations, their need for research by highly skilled mathematicians to support the work of the programmers, so that the magnificent engineering creations are safely and fully exploited. Periodical symposia on this topic, at the high level of this one, will, in the long run, do much to draw to the field of numerical analysis mathematicians of the caliber which it must have.

The contributors are Richard Bellman, Stefan Bergman, R. H. Bruck, D. R. Clutterham and A. H. Taub, Joseph W. Fischbach, S. P. Frankel, Cecil Hastings, Jr., Jeanne Hayward, and James P. Wong, Jr., Magnus R. Hestenes, Emma Lehmer, T. S. Motzkin, P. C. Rosenbloom, Arthur Sard, Olga Taussky, C. B. Tompkins, J. L. Walsh, S. E. Warschawski, Wolfgang Wasow, Helmut Wielandt, and David Young.

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Body Measurements and Human Nutrition. J. Brožek, Ed. Wayne University Press, Detroit, Mich., 1956. 167 pp. Illus. $3.50.

Todd and his associates took physical anthropology out of the dissecting room, the charnel house, and the museum into the world of living persons. Brožek and his associates have taken physical anthropology from the outer living man (surface sizes and contours) to the inner living man (composition of body tissues). Physical anthropology, cumulatively, is the richer, the more "dynamic," for this continuing trend. Man is more than bone, more than surface morphology and morphometry; he is an integrated, functioning biophysiological complex.

Certain minimal body measurements are recommended on adults: weight, stature, bicristal and biacromial diameter, upper arm skinfold, scapular skin fold, and upper arm circumference. In children these measurements vary according to age. Maturation stage is an important factor in interpreting dimensionality. In a study, "Physique and nutritional status of adult man," Brožek predicted body weight from height, cristal height, bicristal and biacromial breadths, humeral bicondylar breadth, upper arm circumference and tissue thicknesses, and age. The multiple $R = 0.770$. Robert M. White reported on "Body build and body weight in 25-year-old army men," relating stature and body build. Mildred Trotter, in a study "Variable factors in skeleton weight," reported that "the internal structure of the femur is more highly correlated with the weight of the skeleton than diameters." Russell Newman reported on "Skinfold measurements in young American males," finding a "racial contrast." Young Negro males were lean and deficient in subcutaneous fat over the pectoral and triceps region. There were observable geographic differences.

Pascale, Grossman, Sloane, and Frankel reported on "Correlations between thicknesses of skinfolds and body density in 88 soldiers." They derived the following multiple correlation equation: $\hat{Y} = 1.088468 - .007123X_1 - .004834X_2 - .005513X_4$. Here $\hat{Y}$ is estimated body density and X_1, X_2, and X_4 are centimeters of fold thicknesses at chest midaxillary, chest at nipple, and dorsum of upper arm. Kurlander, Abraham, and Ryan discussed "Obesity and disease," concluding "that some (or all) of the association between weight and disease may actually be due to body build rather than to obesity."

In this review I have limited myself to what seemed the salient conclusions of the majority of the authors. However, I would emphasize that I have omitted much detail by presenting essentials. I was impressed by the logical "flow" of the papers. The Committee on Nutritional Anthropometry, Food and Nutrition Board, National Research Council is to be congratulated on the material selected for the conference that is reported in this book; Brožek deserves commendation for the uniformity of writing and editorial style.

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Currents, Fields, and Particles. Francis Bitter. Technology Press, Cambridge, Mass.; John Wiley, New York; Chapman & Hall, London, 1956. 599 pp. Illus. $8.50.

One consequence of the increased specialization in the average college physics curriculum is the odd fact that the unified field comprising physics as a whole is met by the student only once, during his freshman year; and at that, owing to the level of student preparation in the freshman year, this over-all

view of physics might be more appropriately described as a mere glimpse.

Francis Bitter has attempted, with rather striking success, to treat in this textbook the gross macroscopic or integrated phenomena side by side with the examination of the microscopic processes vitally involved. The scope of the subject matter covered is broad, extending from electricity and magnetism and optics through modern and nuclear physics. For institutions offering an intensive course in physics and the calculus during the freshman year, the level of the present textbook might be placed at the sophomore, or possibly the junior, year.

The comprehensive view presented the student is perhaps best illustrated by citing the topic headings in the chapter on "The electrical properties of matter": (i) electrons and protons; (ii) Rutherford and the nuclear atom; (iii) excitation and ionization; conduction in gases and solutions; (iv) metals and semiconductors; resistivity; (v) polarization; (vi) displacement currents and displacement; (vii) the energy in polarized dielectrics; (viii) electrical measurements; (ix) Kirchhoff's rules; (x) time constants; (xi) impedance—electronics.

The textbook is also provided with an ample number of problems, running through a complete range of complexity. The aforementioned chapter, for example, has 44 problems of which at least ten may be categorized as searching.

A sophomore-year course based on this textbook could be used to lead to the more specialized subjects, with a treatment substantially more advanced than is current practice. This would be particularly true if this year were also spent in increased mathematical preparation.

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A Handbook of Hardwoods. Compiled by the Forest Products Research Laboratory, Department of Scientific and Industrial Research. H. M. Stationery Office, London, 1956 (order from British Information Services, 20 Rockefeller Plaza, New York 20). 269 pp. $3.15.

This handbook brings together the sections on hardwood in two of the laboratory's earlier handbooks, *Homegrown Timbers* (1945) and *Empire Timbers* (1941). The present volume has been considerably expanded to include more species and additional data as well as a tabular guide, for quick reference, to the properties of the more commonly used timbers.

Traité de Pharmacie Chimique. vol. I, **Chimie Minérale.** vol. II, **Chimie Organique.** Série acyclique. Composés non azotés. Série cyclique. Composés non azotés. vol. III, **Chimie Organique.** Série cylique. Composés organiques azotés. Série hydroaromatique. Série terpenique, Stérols et acides biliaires. Vitamines. Hormones. Composés organo-minéraux. vol. IV, **Chimie Organique.** Composés hétérocycliques. Matières colorantes artificielles. Antihistaminiques. Alcaloïdes. vol. V, **Chimie Organique.** Hétérosides. Protides. Produits divers. Antibiotiques. P. Le Beau et M.-M. Janot, Ed. Masson, Paris; Stechert-Hafner, New York, ed. 4, 1955–56. 4978 pp. Cloth, F. 37,000 for 5 vols.; paper, F. 32,000 for 5 vols.

This is a reference work of the first magnitude. From its attractive black, red, and gold covers to its comprehensive indexes, it is a work that is masterfully conceived and skillfully executed. Its two principal authors and their six collaborators, all of whom, with one exception, are members of the Faculté de Pharmacie de Paris, are to be congratulated in bringing out this new edition.

The previous edition, the third, which appeared in 1947, numbered some 4450 pages divided among four volumes; this present opus has an additional 500 pages requiring the introduction of another volume, the fifth. The printing is well done and the choice of type face makes it easy to read. (Those for whom French is not their native tongue should not find it difficult reading because the style is simple and straightforward.)

Of the five volumes only the first is devoted to inorganic substances of medicinal and pharmaceutical interest, the remaining four being concerned with organic compounds. Because of this division the authors have furnished two indexes, one at the end of volume I for the inorganic elements and compounds, and the other at the end of volume V to cover all the material of volumes II to V. These indexes are rather complete, the first numbering 27 pages and listing about 4500 entries for 800 pages of text; the second index includes 157 pages and lists about 22,500 entries for almost 4000 pages of material. In cases where a compound or preparation has several synonyms or trade names, cross references are given, thus making the indexes eminently useful.

The references, indicated by small superscripts in the text, are found at the bottom of the appropriate pages. Although the selection of references makes no attempt at being complete, it seems, for the most part, to be adequate, inasmuch as both the old and newer literature is cited. Since a work of such magnitude could not be readily completed except over a period of time, the authors have provided some 55 pages of addenda, at the end of the first and fifth volumes, containing references to recent publications—for example, the 15th revision of the *United States Pharmacopeia*.

Because the present state of our knowledge does not permit an adequate classification of chemical substances according to their physiological or pharmacological properties, it is necessary to employ a scheme which, in great measure, is based on chemical principles. Thus, this involves, for the inorganic substances, the use of the periodic table, while the division of organic preparations and compounds generally follows functional groupings. A slight departure from this order is made when separate chapters in the volumes dealing with organic compounds are given over to the consideration of antibiotics, antihistamines, toxins, venoms, hormones, and vitamins. A valuable addition to the first volume is a chapter that discusses the natural and artificial radioactive substances.

In the volume dealing with the elements and their inorganic compounds, the basic order of treatment is uncomplicated. Each chapter covers one element and its compounds with a brief introduction, which includes a history of our knowledge of the element, some technologic data such as production figures, natural distribution, methods of commercial preparations, and some economic statistics. For each compound there is given the chemical formula, the percentage by weight of the elements comprising it, synonyms and trade names, methods of preparation, chemical and physical properties, assay, use, physiological and pharmacological properties, and remarks. This pattern is followed, with some variations as needed, throughout the entire set.

The order of the four volumes dealing with the organic compounds is somewhat more involved. Of the several possible methods of organizing the extensive material, the authors chose to follow one based on functional groupings. Volume II deals with the nonnitrogenous cyclic and acyclic compounds. Volume III includes cyclic nitrogenous compounds, aromatic hydrocarbons, terpenes, sterols, vitamins, hormones, and metal-organic compounds. The following volume (IV) covers the heterocyclic compounds, synthetic dyes, antihistamines, and alkaloids. The last volume (V) deals with the heterosides, protides and derivatives, and antibiotics.

In so extensive a coverage one could find items to which exception might be

taken. One may wonder, for example, why no mention is made of the use of sodium fluoride as a dental prophylactic, although a few comments are made on its toxic action on teeth. Or, again, the melting point of chlorpromazine hydrochloride is given as 180°C notwithstanding that the value more generally cited is closer to 195°C (as it is in the supplement to the 15th revision of the *U.S.P.*). Many, if not most, of the typographic errors were picked up by the authors and are listed in the several pages of errata. Despite these slight imperfections, the over-all work is not marred; it remains an excellent contribution to the field of pharmaceutical chemistry.

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Procedure in Taxonomy. Including a reprint in translation of the Regles Internationales de la Nomenclature Zoologique. With titles and notes on the opinions rendered to the present date (1907 to 1956). Completely indexed. Edward T. Schenk and John H. McMasters. A. Myra Keen and Siemon W. Muller, Eds. Stanford University Press, Stanford, Calif., ed. 3, 1956. vii + 119 pp. $3.50.

Almost a third of this book is devoted to succinct recommendations and clarifications of procedure in taxonomic practice, particularly in the nomenclature of systematic categories, in the designation of type specimens, in the storage of type material, in the naming of genera and species, in the treatment of synonymy, and in the descriptions of new species. The chapters are brief summaries and are far from being exhaustive treatments of the more difficult problems. A short history of the International Commission on Zoological Nomenclature is added. The rest of the book contains a reprint of the latest revision of the International Code of Zoological Nomenclature, together with summaries and titles of opinions rendered through 19 June 1956, titles to declarations of the international commission made through 19 June 1956, and directions issued by the international commission from 1954 to 17 May 1956. A good subject index to cited names and topics is appended.

The book is a handy manual for the practicing taxonomist and should facilitate clear and concise taxonomic publication. Little excuse remains for the errors and ambiguities of the past, particularly the confusions of the 19th-century literature before the codification of the rules of nomenclature.

Genetic homology through evolutionary change provides a testable principle underlying systematic order. Nomenclature is mainly a tool for bibliographic continuity for comparative biological knowledge. General international agreement on the names of animals, together with a fluid order of symbolic expressions as knowledge increases and past errors are detected, renders taxonomic nomenclature superior to the nomenclatural systems used in any other branch of biology. When the strict application of the rules results in greater confusion, the rules may be suspended after a careful review of each case.

Protests by individuals or groups concerning special aspects of the rules as applied to particular cases are welcomed and judged on their merits by the international commission. Decisions are sometimes reversed when new information is obtained. Final stabilization of animal names with rapid advance in knowledge and scholarship is not possible in the foreseeable future, but uniform procedure in establishing and changing names is greatly enhanced through the work of the international commission and the international congresses. Relative stabilization is attained through common agreement with freedom of expression and action leading to reform and progress. Individuals and groups sometimes differ from the recommendations of the international code and often publish names at variance with the rules. In the long run, the gradually improving code usually prevails.

The problem of handling the names of millions of organisms studied by hundreds of thousands of individuals over the years in many parts of the world is almost overwhelming. Great praise should be given to the taxonomists and their organizations for a system that demonstrably operates so effectively. Systematics is rapidly taking its rightful place as a major subscience which interacts with all the other biological sciences. Nomenclature is a system of symbols that facilitates the comparative study and advance of biology.

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Valency and Molecular Structure. E. Cartmell and G. W. A. Fowles. Academic Press, New York; Butterworths, London, 1956. 256 pp. Illus. $5.80.

In this small book the authors give a brief introductory discussion of quantum theory and atomic structure, and a rather detailed, though succinct, treatment of the quantum theory of valence and of molecular structure. The topics covered are black-body radiation and other phenomena lying at the basis of quantum theory, the Bohr theory, the spinning electron, the wave equation, the wave functions for hydrogenlike orbitals, the relation of the periodic table to the electronic structure of atoms, the valence-bond method of approximate quantum mechanical discussion of molecules, the molecular orbital method, directed valence bonds and hybrid orbitals, bond energies, the sizes of ions, the hydrogen bond, the metallic bond, van der Waals interaction, the structures of simple inorganic compounds, the structures of complexes, and the structures of electron-deficient molecules.

Most of the treatment of these topics is conventional. The authors write in a clear and lucid style. Occasionally the discussion of a theoretical point is so brief as to give rise to the danger of misunderstanding by the student reader, for whom the book is designed. References are given at the end of each chapter. Usually these references are not to original papers but to review articles.

This book should be useful in serving the purpose for which it was written, that of helping to bring new life into the teaching of inorganic chemistry.

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Treatise on Invertebrate Paleontology. Part F, **Coelenterata.** Raymond C. Moore, Ed. Geological Society of America and University of Kansas Press, New York, 1956. 498 pp. Illus. $7.

This welcome addition to the invaluable *Treatise on Invertebrate Paleontology* obviously owes much to the indefatigable labors on the part of the editor who has succeeded splendidly in collating and systematizing the parts written by a number of collaborators. As in the preceding volumes of the series, the accounts are not limited to extinct forms but take into consideration all members of the phylum, placing them systematically in an arrangement that, if not finally acceptable, at least facilitates the study of the phylum. I consider unfortunate the retention of ctenophores in the phylum, although it now appears that there is at least one ctenophore with intrinsic nematocysts.

In the introduction by Hill and Wells the statement that Cnidaria have fundamentally biradial structure is incomprehensible and seems to indicate a lack of understanding of the term *biradial*. Actually the Cnidaria have fundamentally tetramerous radial symmetry, unless one adheres to the theory that the phylum was originally bilateral. It is interesting to note that the oldest cnidarian fossils

are of the medusoid type. An excellent discussion of extinct medusoid forms is given by Harrington and Moore, and this seems to be the first occasion on which this information has been brought together and systematized.

Boschma has given a satisfactory account of *Milleporina* and *Stylasterina*. The Stromatoporoidea by Lecompte are placed under Hydrozoa, although admittedly their position here is not firmly established; that they are coelenterates appears acceptable. Bayer has given an exceptionally clear introductory account of the alcyonarian or octocorallian anthozoans, illustrated with original figures, and the account has been worthily completed by Eugenia Montanaro-Gallitelli, also with numerous original figures.

The rugose corals by Dorothy Hill probably presents as good a classification of these difficult forms as has been published, even if perhaps not final; the account is well illustrated. The stony or scleractinian corals by Wells begins with a long introduction that is often not very clear and seems to multiply technical terms; the well-illustrated systematic account of the stony corals practically follows that of Vaughan and Wells (1943). The book concludes with an account of the tabulate corals by Hill and Stumm.

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Handbuch der Physik. vol. 1, *Mathematical Methods.* S. Flugge, Ed. Springer-Verlag, Berlin, 1956. 364 pp. Illus. DM. 72.

The first volume of the new *Handbuch* contains five articles. The first three were prepared by J. Lense and deal with the principles of analysis, ordinary differential equations, and theory of complex functions (90 pages), partial differential equations (30 pages), elliptic functions (27 pages). The last two articles are by J. Meixner and F. Schlögl. They deal with the special functions of mathematical physics (71 pages) and boundary-value problems (135 pages), respectively. There are short bibliographies and, in addition to the subject index in German, there is an English index.

A comparison of the wealth of the material treated in the articles with the space that was available shows that only a compendiumlike treatment of the subject was possible. I approached the volume in a somewhat skeptical spirit. I was doubtful whether an adequate treatment of the material is at all possible, whether it is desirable for the physicist to learn mathematics from a compressed treatment, as the present one has to be, and, if not, whether a mere statement of mathematical results without proofs or examples is at all helpful. Certainly, one must fear that it invites misunderstandings and errors.

On the whole, these apprehensions were not justified. Most of the material is clearly presented; even where proofs are omitted, the statement of the theorems is clear so that misunderstandings are not likely to arise. Whether a physicist who faces a mathematical problem with which he has no familiarity can advantageously use this book remains doubtful. However, there may be many instances in which this "Nachschlagewerk" will help him recall developments which he once knew but on which his memory is vague, and in some cases it may carry him beyond the limits of his previous knowledge. The book is well worth possessing, and I often found it more stimulating and striking than some of the standard textbooks.

The amount of material presented or reviewed is truly surprising. The first article reviews the standard material of elementary analysis, including the basic theorems on complex functions. It contains short tables of the properties of elementary transcendentals, their derivatives and integrals. It also gives some more esoteric facts concerning the convergence of power series on the circle of convergence, describes the properties of gamma functions and a few transformations in the complex plane, and ends up with a brief discussion of ordinary differential equations. The second article, on partial differential equations, gives the theory of characteristics and, hence, of linear first-order differential equations rather completely. It also defines the complete integral of a first-order equation—a theory that is very important for the understanding of the Hamilton-Jacobi equation but is nearly universally forgotten. The third article, on elliptic functions, is perhaps the most elegant and, considering its length, remarkably complete.

The treatment of the special functions of mathematical physics also goes much beyond the material usually considered. It defines and describes hypergeometric series and the limiting cases, such as Bessel functions and spherical harmonics. It then proceeds to a rather extensive theory of linear second-order ordinary differential equations, the coefficients of which are rational functions of the independent variable. The hypergeometric functions are reviewed again as solutions of differential equations of this type. The next two sections of this article, referring to addition and multiplication theorems as well as to difference equations involving the hypergeometric functions, will be new for most readers. The last section treats the same functions from a somewhat more modern point of view.

The last article, on boundary-value problems, is the only one which contains parts that I feel compelled to criticize. The treatment of the spectral theory of self-adjoint operators is antiquated in its methods and many of the statements are misleading. At places there is a pretense of proofs, which is worse than no proof at all; at other places the theorems, without proofs, are inaccurately formulated. It is regrettable that this happens with the spectral theory, the basis of quantum mechanics. Few easily readable treatments of this subject are available, and a real opportunity was missed to acquaint the theoretical physicist with a subject of great concern to him. The rest of the article is, on the other hand, modern and stimulating. It contains a discussion of variational calculus and several examples of integral and differential operators. It ends with a discussion of Green's functions and the various D functions used in modern quantum field theories.

On the whole, the book appears to be useful and sets a fine standard for the rest of the *Handbuch*. The minor inadequacies are no doubt at least partially due to lack of space in a very condensed volume.

EUGENE P. WIGNER
Princeton University

Electrochemical Affinity. Studies in electrochemical thermodynamics and kinetics. Pierre Van Rysselberghe. Hermann, Paris, 1955. 109 pp. F. 1250.

Recent books on the thermodynamics of irreversible processes (De Groot, Denbigh, Prigogine) do not contain detailed treatments of electrode reactions. The monograph by Pierre Van Rysselberghe fills this gap very satisfactorily. As the author points out, this book can be regarded as an extension of the work on the chemical affinity he wrote in collaboration with De Donder (1936).

The book is divided in five chapters covering the following topics: galvanic and electrolytic cells, reversible and irreversible electrode processes, simultaneous half-reactions at the same electrode, the Tafel equation and some aspects of electrochemical kinetics, and thermoelectricity. The approach is original and, in many instances, cannot be found elsewhere. Recent developments in the thermodynamics of irreversible processes, particularly the concept of entropy production and Onsager's reciprocity relations are fully exploited. They provide a rational basis for the study of electrode reactions in general, and they are especi-

ally useful in the discussion of coupled electrochemical reactions and cells with thermal gradients.

Experimental implications of the theory are discussed throughout the book. For instance, the reader will be much interested in the treatment of corrosion reactions and the new idea that currents cannot be added algebraically in all rigor in the case of coupled electrode reactions.

This timely and well-written book should prove most interesting and stimulating to electrochemists and physical chemists.

PAUL DELAHAY
Louisiana State University

Introduction to Mathematical Logic. vol. 1. Princeton Mathematical Series, No. 17. Alonzo Church. Princeton University Press, Princeton, N. J., 1956. 384 pp. $7.50.

The first volume of Alonzo Church's projected two-volume textbook on mathematical logic is now available as No. 17 in the Princeton Mathematical Series. Its excellence in every respect requires no comment. A revised and greatly expanded edition of the author's well-known contribution of 1944 to the *Annals of Mathematics Studies,* the work is addressed to beginners in logic who possess a respectable mathematical background. As the preface notes, it is also intended for use "within limitations as a reference work." The principal business at hand is formalizing an object language, with theoretical syntax treated informally and semantical matters introduced primarily to motivate interest in the uninterpreted logistic systems. Generous footnotes together with special sections of the text give sources and fill in the historical background. A noteworthy feature is the large and varied collection of exercises. The problems range from those suitable for routine practice through others that are, in effect, "brief sketches of difficult developments to which whole sections of the main text might have been devoted."

Volume I consists of an introduction and five chapters. In the introduction the reader makes the acquaintance of proper and improper symbols, the logistic method, and the world of abstract objects—"meanings," propositions, truth-values, and functions—with the treatment of proper names, and of sentences as names of a special kind, adopted with minor modifications from Frege. Chapter I develops the various theorems and metatheorems of the propositional calculus in a formulation in which the primitive connectives are implication and a constant f, the O-ary connective denoting the truth-value falsehood in the intended principal interpretation. Chapter II offers an alternative formulation in which the primitive connectives are implication and negation. The two systems are shown to be equivalent, other formulations are developed, and various partial systems are considered.

Chapter III develops simultaneously the various functional calculi of the first order, the device of axiom schemata making unnecessary the use of primitive rules of substitution. The subjects treated include consistency, the deduction theorem, and duality. Chapter IV examines the pure functional calculus of first order, a system whose primitive symbols include all the propositional and functional variables but neither individual nor functional constants. Most of the developments apply in both the previous formulation and in an alternative formulation in which a finite number of axioms replace the axiom schemata. The subjects treated include Gödel's completeness theorem. Löwenheim's theorem, and the solution of the decision problem in special cases.

Chapter V offers proofs of consistency and completeness for some of the functional calculi of second order. It also considers certain axioms, including various axioms of infinity, that can be expressed in the notation of the system under investigation, and closes with a note on the ramified functional calculi of second order. A digression, occupying more than a third of the chapter, shows how postulates, either as added axioms of a logistic system or as propositional functions, may serve as a basis for a special branch of mathematics.—J.T.

Chemistry of Carbon Compounds. vol. III, pt. B. *Aromatic Compounds.* E. H. Rodd, Ed. Elsevier, Amsterdam–Princeton, 1956 (order from Van Nostrand, Princeton, N.J.). 1669 pp. Illus. $25.

This book is a direct continuation of volume III, part A, completing the survey of aromatic compounds. The high standard of the previous volumes in the series is maintained, and there is a remarkable uniformity in the presentation of chapters by different authors. The literature seems to have been well covered up to about 1954 with occasional references to material published in 1955.

The chapters in this book serve as an excellent introduction to the study of a particular class of compound and for one seeking analogous reactions in a field other than his own. This subvolume covers the chemistry of benzoquinones; oxygen-containing derivatives of phenols (salicylic acid, hydrolyzable tannins, and so forth); polyhydric aromatic alcohols and their oxidation products (phthalic acid, mandelic acid, and so forth); unsaturated benzene derivatives (styrene, cinnamic acid, and so forth); phenylbenzenes; di-, tri-, and tetraphenylmethanes; di- and polyphenyl alkanes (paracyclophanes, benzilic acid, chalkones, and so forth); quasi-aromatic compounds (tropolone, diazocyclopentadiene, and so forth); bicyclic condensed nuclei (naphthalene, azulene, indene, and so forth); and finally compounds with three or more condensed aromatic nuclei (anthracene, phenanthrene, and so forth).

Historical accounts of the elucidation of the structure of natural products have, in general, been omitted and wisely so. It is good to see brief accounts of the biological aspects of various compounds or class of compound in the text. The mechanistic aspect of organic chemistry is not emphasized, but topics such as the Claisen rearrangement, ketene reactions, and tropolone chemistry are dealt with competently and with restraint. Ample references are given throughout to recent work on the physical-organic aspects of the subject matter.

The chapters on naphthalene, anthracene, and the more complex hydrocarbons are inevitably condensed, and it is probable that a person desiring information on compounds in this section will consult the published volumes of Elsevier's *Encyclopedia of Organic Chemistry.* However, this treatise is more pleasant to read than an encyclopedia, with numerous clear structural formulas breaking up the text. Misprints are few, the binding is good, and the book should withstand frequent consultation. It is a book that all organic chemists will wish to possess.

EDWARD LEETE
University of California, Los Angeles

New Books

Synthetic Polypeptides. Preparation, structure and properties. C. H. Bamford, A. Elliott, W. E. Hanby. Academic Press, New York, 1956. 445 pp. $10.

Chemical Process Economics in Practice. J. James Hur, Ed. Reinhold, New York; Chapman & Hall, London, 1956. 115 pp. $3.95.

The Person behind the Disease. Julius Bauer. Grune & Stratton, New York, 1956. 136 pp.

Your Child's Speech. A practical guide for parents for the first five years. Flora R. Schreiber. Putnam's, New York, 1956. 256 pp. $3.50.

The Reactive Intermediates of Organic Chemistry. John E. Leffler. Interscience, New York, 1956. 275 pp. $6.

The Psychology of Sex Offenders. Albert Ellis and Ralph Brancale. Thomas, Springfield, Ill., 1956. 132 pp. $3.75.

Modern Instruments in Chemical Analysis. Frank M. Biffen and William Seaman. McGraw-Hill, New York, 1956. 333 pp. $7.50.

Atomic Energy for Your Business. Today's key to tomorrow's profit. Arnold Kramish and Eugene M. Zuckert. McKay, New York, 1956. 269 pp. $3.95.

Wing Theory. A. Robinson and J. A. Laurmann. Cambridge University Press, London, 1956 (order from Cambridge University Press, New York). 569 pp. $13.50.

History of Analytic Geometry. Scripta Mathematica Studies, Nos. 6 and 7. Carl B. Boyer. Scripta Mathematica, Yeshiva University, New York, 1956. 291 pp. $6.

Strahlendosis und Strahlenwirkung. Tafeln und erlauterungen unterlagen fur den strahlenschutz. B. Rajewsky. Thieme, Stuttgart, 1956 (order from Intercontinental Medical Book Corp., New York 16). 486 pp. $8.60.

Rheology, Theory and Applications. vol. 1. Frederick R. Eirich. Academic Press, New York, 1956. 761 pp. $20.

Biological Treatment of Sewage and Industrial Wastes. vol. I. *Aerobic Oxidation.* Brother Joseph McCabe and W. W. Eckenfelder, Jr., Eds. Reinhold, New York; Chapman & Hall, London, 1956. 393 pp. $10.

Tables of Physical and Chemical Constants and Some Mathematical Functions. Originally compiled by G. W. C. Kaye and T. H. Laby. Prepared under the direction of an editorial committee. Longmans, Green, New York, ed. 11, 1956. 233 pp. $5.

Lehrbuch der Tropenkrankheiten. Ernst G. Nauck. Thieme, Stuttgart, 1956 (order from Intercontinental Medical Book Corp., New York 16). 432 pp. $15.25.

The Compleat Cruiser. The art, practice and enjoyment of boating. L. Francis Herreshoff. Sheridan House, New York, 1956. 372 pp. $5.

Organic Syntheses. An annual publication of satisfactory methods for the preparation of organic chemicals. vol. 36. N. J. Leonard, Ed. Wiley, New York; Chapman & Hall, London, 1956. 120 pp. $3.75.

Man of High Fidelity: Edwin Howard Armstrong. Lawrence Lessing. Lippincott, Philadelphia, 1956. 320 pp. $5.

Phase Diagrams in Metallurgy. Their development and application. Frederick N. Rhines. McGraw-Hill, New York, 1956. 340 pp. $12.

The Study of Plant Communities. An introduction to plant ecology. Henry J. Oosting. Freeman, San Francisco, ed. 2, 1956. 440 pp. $6.

International Review of Cytology. vol. V. G. H. Bourne and J. F. Danielli, Eds. Academic Press, New York, 1956. 570 pp. $11.50.

Stormy Life. Memoirs of a pioneer of the air age. Ernst Heinkel. Jürgen Thorwald, Ed. Dutton, New York, 1956. 256 pp. $5.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

The Geology and Vertebrate Paleontology of Upper Eocene Strata in the Northeastern Part of the Wind River Basin, Wyoming. pt. 2, *The Mammalian Fauna of the Badwater Area.* Smithsonian Misc. Coll., vol. 131, No. 8. C. Lewis Gazin. Smithsonian Institution, Washington, 1956. 35 pp.

Rauwolfia and Its Alkaloids. A bibliography: chemistry, pharmacology, pharmacognosy, therapeutic uses. Penick Research Div. S. B. Penick & Co., New York 8, 1956. 50 pp.

Chemical and Mechanical Stabilization. Highway Research Board Bull. 129. National Academy of Sciences–National Research Council, Washington, 1956. 110 pp. $2.25.

Institute of Medical and Veterinary Sciences, South Australia, Seventeenth Annual Report of the Council. July 1954–June 1955. Institute of Medical and Veterinary Science, Adelaide, Australia, 1956. 113 pp.

Novitates Himalaicae—I. Bulletin of Botany, vol. 2, No. 3. British Museum (Natural History) London, 1956. 17 pp. 10s.

Emergency Medical Care in Disaster, a Summary of Recorded Experience. A special report prepared for the Committee on Disaster Studies. Disaster Study No. 6. National Academy of Sciences–National Research Council, Washington, 1956. 75 pp.

Teachers of Children who are Partially Seeing. A report based on findings from the study *"Qualification and Preparation of Teachers of Exceptional Children."* Romaine P. Mackie and Edith Cohoe. U.S. Office of Education, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 71 pp. $0.30.

The Hazards to Men in Ships Lost at Sea, 1940–44. Medical Research Council Special Report Series, No. 291. R. A. McCance, C. C. Ungley, J. W. L. Crosfill, and E. M. Widdowson. H. M. Stationery Office, London, 1956. 44 pp. 5s.

Laboratory Manual for Students of Agronomy. L. F. Graber. Wm. C. Brown, Dubuque, Iowa, ed. 9, 1956.

Department of Scientific and Industrial Research, New Zealand, Departmental Handbook. Information Series, No. 9. Information Bureau, DSIR, Wellington, N.Z., ed. 3, 1956. 71 pp.

Two New Species of Philogenia From the Panama Canal Zone (Odonata: Coenagriidae). Bull. of the Florida State Museum, Biological Sciences, vol. 1, No. 4. Minter J. Westfall, Jr., and Robert B. Cummings. University of Florida, Gainesville, 1956. 12 pp. $0.25.

John and Mary R. Markle Foundation, 1955–1956 Annual Report. John and Mary R. Markle Foundation, New York 17, 1956. 79 pp.

Publication Index 1950–1955. Highway Research Board. National Academy of Sciences–National Research Council, Washington 25, 1956. 103 pp. $1.95.

Further Data on African Parasitic Cuckoos. Proceedings of the United States National Museum, vol. 106, No. 3374. Herbert Friedmann. 32 pp. U.S. National Museum, Smithsonian Institution, Washington 25, 1956.

New York State Museum and Science Service, Lists of Publications. New York State Museum and Science Service, Albany 1, N.Y. Free.

Home Health Emergencies. A guide to home nursing and first aid in family health emergencies. Medical Department, Equitable Life Assurance Society of the United States, New York 1, 1956. 256 pp. Available on request.

The Relations Between Scientific Research in the Universities and Industrial Research. A report on conditions in Great Britain. V. E. Cosslett, Ed. International Association of University Professors and Lecturers, London, 1955. 187 pp. 15s.

United Kingdom Postgraduate Awards (Fellowships, Scholarships, Grants, Etc.) 1956–57. List of awards tenable at Universities in the United Kingdom. Short list of awards tenable overseas. Association of Universities of the British Commonwealth, London, W.C.1, ed. 9 revised, 1956. 130 pp.

The Anthropometry of Working Positions. I. A Preliminary Study. WADC Technical Report 54–520. ASTIA Document No. AD 39439. H. T. E. Hertzberg, Irvin Emanuel, and Milton Alexander. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1956 (order from ASTIA Document Service Center, Knott Building, Dayton 2, Ohio). 12 pp.

Annuaire Hydrologique de la France, 1955. Société Hydrotechnique de France, Paris VII, 1956. 206 pp.

Breeding and Other Habits of Casqued Hornbills (Bycanistes Subcylindricus). Smithsonian Misc. Coll., vol. 131, No. 9. Lawrence Kilham. Smithsonian Institution, Washington 25, 1956. 45 pp.

Federal Funds for Science. V. *The Federal Research and Development Budget, Fiscal Years 1955, 1956, and 1957.* NSF 56–19. National Science Foundation, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 47 pp. $0.35.

Inter-American Tropical Tuna Commission, Annual Report, 1955. The Commission, La Jolla, Calif., 1956. 95 pp.

Ancient and Modern Man in Southwestern Asia. Henry Field. University of Miami Press, Coral Gables, Fla., 1956. 342 pp.

Curing of Concrete, 1925–1955. Highway Research Board Bibliography 18. National Academy of Sciences–National Research Council, Washington, 1956. 98 pp. $1.80.

The Physics of Nuclear Reactors. A conference arranged by the Institute of Physics, London, 3–6 July 1956. *British Journal of Applied Physics,* Suppl. No. 5. The Institute of Physics, London, 1956. 112 pp. 25s.

American Museum of Natural History, Eighty-Seventh Annual Report, July 1955, through June 1956. The Museum, New York, 1956. 75 pp.

Meetings and Societies

Programs at AAAS New York Meeting

The programs of many of the AAAS sections and affiliated societies for the forthcoming annual meeting of the association in New York were announced in November issues. The topics for presentation and discussion in psychology, agriculture, industrial science, and science in general are given here.

Psychology (in Part)

Section I. Invited papers: "Experimental approaches to research with children"; arranged by Wendell E. Jeffrey, University of California, who will preside; 26 Dec., afternoon. Research on work and energy variables, C. G. Screven, University of Wisconsin; Research on anxiety and stress, Alfred Castaneda, State University of Iowa; Research on discrimination, W. E. Jeffrey, University of California; Research on problem solving, T. S. Kendler, Barnard College.

Invited papers: "Avoidance conditioning and anxiety"; arranged by Gregory A. Kimble, Duke University, who will preside; 27 Dec., morning. Avoidance learning and the concept of anxiety, H. I. Kalish, Adelphi College; Some relations between avoidance conditioning and conditioned anxiety, Murray Sidman, Walter Reed Army Institute of Research; Semantic generalization of anxiety conditioned without awareness, J. I. Lacey, Antioch College; Conditioned fear, conditioned avoidance, and the problem of neurosis, H. F. Hunt, University of Chicago.

Invited papers: "Motivational and rewarding effects of direct stimulation of the brain"; arranged by Neal E. Miller, Yale University, who will preside; 28 Dec., morning. Learning and performance motivated by direct stimulation of the brain, Neal E. Miller; Effects of hunger, sex, and tranquilizers on localized reward systems in the brain, James Olds, University of California School of Medicine; Interference effects of central stimulation, J. R. Knott, State University of Iowa; Motivational-emotional factors and intracranial self-stimulation, J. V. Brady, Walter Reed Army Institute of Research.

Agriculture

Section O. Contributed papers on forage production; Karl S. Quisenberry, U.S. Department of Agriculture, presiding; 27 Dec., morning.

Contributed papers on economics of forage; J. K. Pasto, Pennsylvania State University, presiding, 27 Dec.; evening.

Contributed papers on forage production; R. B. Alderfer, Rutgers University, presiding; 27 Dec., evening.

Contributed papers on evaluation of forages; O. E. Sell, Georgia Experiment Station, presiding; 28 Dec., morning.

Four-session symposium, cosponsored by 17 societies: "Grasslands in our national life"; arranged by Howard B. Sprague, Pennsylvania State University; 29 and 30 Dec., mornings and afternoons. Part I, "Forage utilization and related animal nutrition problems"; D. W. Colvard, North Carolina State College, presiding. Different methods of utilizing forage in dairy cattle nutrition (grazing versus soiling versus haying versus ensiling), J. W. Bartlett, R. E. Mather, and J. L. Casin, Rutgers University; Mineral problems in forage utilization, G. K. Davis, University of Florida, and K. C. Beeson, U.S. Plant, Soil, and Nutrition Laboratory; Nutritive value of forages with emphasis on the polysaccharide fractions, R. E. Ely and L. A. Moore, U.S. Department of Agriculture; Estrogenic substances in forages, E. W. Cheng and W. Burroughs, Iowa State College. Part II, "Forage production in temperate humid regions"; R. P. Murphy, Cornell University, presiding. The place and contribution of grasslands to the agriculture of the corn belt, M. B. Tesar, Michigan State University; The place and contribution of grasslands to the agriculture of the eastern states, J. B. Washko and H. R. Fortmann, Pennsylvania State University; Establishment and maintenance of grasslands in the temperate humid region, H. A. MacDonald, Cornell University; Disease control of grasslands in the temperate humid region, K. W. Kreitlow, U.S. Agricultural Research Service; Insect control of grasslands in the temperate humid region, W. A. Baker, U.S. Agricultural Research Service; Development and use of improved varieties of forage crops in the temperate humid region, A. A. Hanson, U.S. Agricultural Research Service. Part III, "Sciences in support of grasslands research"; Howard B. Sprague, presiding. Plant exploration and the search for superior germ plasm for grasslands, J. R. Harlan, U.S. Department of Agriculture and Oklahoma A. & M. College; Integration of programs in genetics, pathology, and entomology for progress in grasslands research, M. G. Weiss, U.S. Department of Agriculture; Interrelations of physiology, ecology, and soils research to serve grasslands, R. B. Alderfer, Rutgers University; Relation of mineral supply in soils to uptake of nutrients by grassland species, and the influence of such uptake on plant growth and forage value, K. C. Beeson; Microclimate as an index of site adaptation and growth potential for grasslands in the temperate humid regions, M. A. Sprague, Rutgers University; *Better seeds for better grasslands* (movie), C. S. Garrison, U.S. Department of Agriculture. Part IV, "Grassland machinery and equipment, structures, and irrigation systems"; E. G. McKibben, U.S. Department of Agriculture, presiding. Equipment for the establishment and maintenance of grassland, W. C. Hulburt, U.S. Agricultural Engineering Research Branch; Irrigation systems for grassland, T. W. Edminster, U.S. Soil and Water Conservation Research Branch; Vertical mulching, a new dimension in grassland farming, J. M. Spain and J. B. Liljedahl, Purdue University; Equipment for harvesting and transporting forage to site of use or storage, E. A. Silver and A. M. Best, Sperry Rand Corporation; Structures for equipment for storing, handling, and feeding of forage, J. D. Long, Stran-Steel Corporation.

Contributed papers on utilization of grassland by livestock; T. C. Byerly, U.S. Department of Agriculture, presiding; 29 Dec., evening.

Contributed papers on applications of engineering; William C. Wheeler, University of Connecticut, presiding; 29 Dec., evening.

American Society of Range Management. Symposium: "Range management"; arranged by F. G. Renner, U.S. Soil Conservation Service; 28 Dec., afternoon. Breeding improved forage plants for western ranges, W. Keller, U.S. Department of Agriculture; Testing new range forage plants, J. L. Schwendiman, Soil Conservation Service, Pullman, Washington; Soil-vegetation surveys in multiple-use management of western ranges, C. E. Poulton, Oregon State College; Changes in native grasslands due to grazing and climate, G. W. Tomanek, Fort Hays Kansas State College; Brush control in the southwest, H. G. Reynolds, U.S. Forest Service; Improving range resources through management,

Arnold Heerwagen, Soil Conservation Service, Denver.

American Meteorological Society. Symposium: "Grassland climatology"; arranged by John R. Mather, Drexel Institute, who will preside; 28 Dec., afternoon. Grassland environment, C. P. Barnes, U.S. Department of Agriculture; Moisture balance, J. R. Mather, Drexel Institute; Microclimatology, E. R. Biel, Rutgers University; Agricultural meteorology in the Weather Bureau, J. M. Beall, U.S. Weather Bureau; General survey and conclusions, L. B. Leopold, U.S. Geological Survey.

Ecological Society of America. Symposium: "Ecology of grasslands"; arranged by Herbert C. Hanson, Catholic University of America, who will preside; 27 Dec., afternoon. Effects of changes in weather conditions upon grasslands in the northern great plains, R. T. Coupland, University of Saskatchewan; Role of plant succession in grassland improvement, Lincoln Ellison, U.S. Forest Service; Application of ecological principles in range evaluation, E. J. Dyksterhuis, Soil Conservation Service; Nature of the grassland type of community, Calvin McMillan, University of Nebraska.

Industrial Science

Section P. Symposium: "Resource development and population growth"; arranged by Allen T. Bonnell, Drexel Institute of Technology; 28 Dec., morning. Our productive potential, Harrison Brown, California Institute of Technology; Our reproductive potential, Fairfield Osborn, Conservation Foundation. Discussants: Robert Cooke, Population Reference Bureau; Samuel H. Ordway, Conservation Foundation.

Luncheon and vice-presidential address by Earle L. Rauber, Federal Reserve Bank of Atlanta, "Population and economic growth"; 28 Dec.

Science in General

Academy Conference. Junior Scientists Assembly; Zachariah Subarsky, Bronx High School of Science, New York, presiding; 27 Dec., afternoon. The fellowship of science, Paul B. Sears, Yale University; Demonstration: Curiosity at work, Don Herbert, General Electric Company; Panel and audience discussion: What makes a scientist? Paul Witty, Northwestern University, moderating; Panel members: R. T. Bernstein, Columbia University; Sam Brownstein (teacher), General Wingate High School; Grace Geist (student), Forest Hills High School; Evelyn Morholt (teacher), New York City Board of Education; Tym Mott-Smith (student), Bronx High School of Science, New York; Edward Weisbard (student), Stuyvesant High School; Norton Zinder, Rockefeller Institute for Medical Research; Demonstration: Luck, accident, and the prepared mind, H. N. Alyea, Princeton University.

Junior Academy session of the Academy Conference; I. E. Wallen, AAAS Science Teaching Improvement Program, presiding; 28 Dec., afternoon.

Program and panel discussion; Ralph W. Lefler, Purdue University, presiding; 29 Dec., afternoon. Progress report on the AAAS Science Teaching Improvement Program, J. R. Mayor and I. E. Wallen; Panel discussion: What could the federal government do for the academies of science? Panel members: J. A. Campbell, National Science Foundation; L. J. Thomas, University of Illinois; Mrs. B. G. Heatwole, Virginia Junior Academy of Science.

Academy Conference dinner and presidential address; Father Patrick H. Yancey, Spring Hill College; 29 Dec., evening.

American Association of Scientific Workers. Symposium: "Community planning"; arranged by Hans Blumenfeld, Metropolitan Toronto Planning Board; J. T. Howard, Massachusetts Institute of Technology, presiding; 29 Dec., afternoon. The development of the scientific approach to planning, Hans Blumenfeld, Metropolitan Toronto Planning Board; Planning and the physical sciences, F. W. Herring, Port of New York Authority; Planning and the social sciences, Burnham Kelly, Massachusetts Institute of Technology; Applications at the community level, Drayton Bryant, Philadelphia Housing Authority.

American Documentation Institute. Opening session: "Language, logic, and logistics of documentation"; James W. Perry, Western Reserve University, presiding; 28 Dec., morning. Logical structure in language, Noam Chomsky, Massachusetts Institute of Technology; A logician's reaction to recent theorizing in information searching systems, Yehosua Bar-Hillel, Hebrew University, Israel; Scanning encoded abstracts, J. W. Perry and Allen Kent, Western Reserve University.

Annual dinner; Joseph Hilsenrath, National Bureau of Standards, presiding; 28 Dec., evening. Address: The diffusion of knowledge, M. L. Ernst, Greenbaum, Wolff, and Ernst.

Two sessions for contributed papers; 29 Dec., morning.

Panel discussion: Changing patterns of information organization: the interaction of conventional and machine classification theory and practice; Scott Adams, National Institutes of Health, moderating; 29 Dec., afternoon. Panel members: S. N. Alexander, National Bureau of Standards; R. S. Angell, Library of Congress; C. L. Bernier, *Chemical Abstracts*; H. P. Luhn, International Business Machines Engineering Laboratories; J. W. Mauchly, Remington Rand UNIVAC Division, Sperry Rand Corporation; M. F. Tauber, Columbia University.

American Nature Study Society. Mixer and dance for the science teaching societies; 26 Dec., evening.

Session on natural history of the New York City region; arranged by Richard L. Weaver, University of Michigan; 28 Dec., morning. Some reptiles and amphibians of the New York City region, R. B. Fischer, Cornell University; Natural history of Greenbrook Sanctuary, Stephen Collins, Rutgers University; Birding in the New York City area, R. T. Peterson, Old Lyme, Conn.; Fifty years in a swamp, John Kieran, American Museum of Natural History.

Session on making nature study and science fun; arranged by Richard L. Weaver, University of Michigan, who will preside; 28 Dec., afternoon. Nature sounds as a hobby, Stanley Mulaik, University of Utah; Designing nature-inspired fabrics, Viriginia Eckelberry, Babylon, Long Island; Why bird painting is not all fun, Don Eckelberry, Babylon, Long Island; Bringing nature into the elementary-school curriculum, Herman Schneider, City College of New York; Nature exploring in Africa, Glidden Baldwin, Danville, Ill.

Annual showing of kodachromes; 28 Dec., evening. Poetry in color, E. L. Will, State Teachers College, Oneonta, N.Y.; Discussion of ANSS program plans; Showing of Kodachromes, members and friends.

Session on nature in camping; arranged by John Wanamaker, Principia College, who will preside; 29 Dec., morning. Our expanding school camping programs and their needs, Helen Ross, State Teachers College, Fitchburg, Mass.; Training the camp nature and woodcraft counselor, L. B. Sharp, Outdoor Education Association; Developing the camp nature program, Dorothy Treat, National Audubon Society; Where does nature study fit into the camp program? Howard Weaver, University of Illinois; A conservation program for older Scouts, Ted Pettit, Boy Scouts of America.

Conference on Scientific Editorial Problems. Opening session: "Science is useless unless recorded and communicated"; G. L. Seielstad, Johns Hopkins University, presiding; 26 Dec., morning. On communicating science, Gerard Piel, *Scientific American*; Science reporting helps scientists, Nate Haseltine, *Washington Post and Times Herald*; The informative function of the scientific report, S. H. McAloney, Ford Instrument Company.

Session on "Type of coverage for the report and manual reader"; L. E. Neville, American-Bosch Arma Corporation, presiding; 26 Dec., afternoon. Designing the scientific report to accommodate its function, H. F. Arader, University of Penn-

sylvania; Content, form, and style in technical reports, Harold Simpson, Westinghouse Electric Corporation; The technical report as a means of communication, by Mrs. B. G. Heatwole, Staunton, Va.

Session on "Techniques and materials used in scientific and technical writing"; E. A. Stearn, Ramo-Wooldridge Corporation, presiding; 27 Dec., morning. Effective literature search methods, J. W. Perry, Western Reserve University; Common sense in technical writing, R. R. Sholl, New York Air Procurement District; Utilizing the editor-illustrator team, C. M. Johnson, U. S. Naval Electronics Laboratory; Digging for information, Mitchell Marcus, Los Angeles State College.

Session on "Scientific and technical translations"; J. G. Adashko, Ford Instrument Company, presiding; 27 Dec., afternoon. Organizing scientific translation services, A. F. Thompson, National Science Foundation; Role of the scientist in a translation journal, R. T. Beyer, Brown University; Translation in international conferences, Daniel Van Acker, Association of Technical Writers and Editors; Activities of the Pergamon Institute of Russian Science, Technology, and Medicine, I. R. Maxwell, Pergamon Press, Ltd.

Technical Writers Clinic; 27 Dec., evening.

Session on "Who does the scientific and technical writing?" R. T. Hamlett, Sperry Gyroscope Company, presiding; 28 Dec., morning. Who does, indeed? Ralph O'Dette, National Science Foundation; The editor—middleman of scientific communication, E. E. Grazda, *Electronic Design*; Getting engineers to write, P. R. Heinmiller, *General Electric Review*; What makes a technical writer? L. E. Tooker, Ford Instrument Company.

Conference on Scientific Manpower. Session; Paul B. Sears, Yale University, presiding; 26 Dec., afternoon. The program of the National Committee for the Development of Scientists and Engineers, H. L. Bevis, National Committee for the Development of Scientists and Engineers; Discussion: Implications for physical sciences, J. C. Warner, Carnegie Institute of Technology; Implications for engineering, E. P. Stevenson, Arthur D. Little, Inc.; Implications for life sciences, M. O. Lee, Federation of American Societies for Experimental Biology.

AAAS Conference on Mathematics Instruction

The national concern about the shortage of scientific and technical personnel has resulted in a great many activities planned to interest more young people in the study of science and to develop better programs for their training. Special interest on the part of scientists has been directed toward curriculum studies at the secondary-school level. Nearly all the major scientific societies have groups that are now studying this problem. One of the goals of these studies is to make certain that secondary-school and undergraduate college courses in science and mathematics are brought more in line with modern scientific developments.

Perhaps the greatest amount of criticism has been in the area of mathematics. Many believe that the lack of interest in the study of science and mathematics in high school may be due, in considerable part, to what they believe to be the low quality of the teaching of arithmetic in the elementary grades. Recognizing the concern about mathematics instruction and the interest of scientists, as well as mathematicians, in the teaching of mathematics, the AAAS called a Conference on Mathematics Instruction in Washington, D.C., early in October. The conference was made possible by a grant from the Carnegie Corporation of New York. The 26 participants included representatives of the three professional societies in mathematics, the American Institute of Biological Sciences, the American Institute of Physics, the American Chemical Society, and leaders in research in applied mathematics, statistics, and psychology. Also invited to participate were teachers of arithmetic and junior and senior high-school mathematics.

Reports were presented on activities and plans of the Commission on Mathematics, sponsored by the College Entrance Examination Board; the National Council of Teachers of Mathematics curriculum committees at the elementary- and secondary-school levels; the curriculum activities of the Mathematical Association of America; the University of Illinois experiment in secondary-school mathematics; and the Study on Admission to College With Advanced Standing.

In addition to the reports on activities directed toward the improvement of instruction in mathematics, there were discussions of a number of related topics, such as what needs to be done at the elementary-school level, point of view of scientists on mathematics curriculum, problems in teacher education, and possibilities for and the desirability of better coordination of elementary-school, secondary-school, and college programs. In the course of the 2-day discussions, considerable attention was given to the need for emergency action as well as long-term study. The need for research in the learning of mathematics, especially in problems of the motivation of students, including questions of readiness at various age levels for the study of science and mathematics, was emphasized.

In recognition of the fact that professional groups in physics, chemistry, and biology, as well as in mathematics, are now engaged in or making plans for curriculum studies, it was suggested that there should be at least one central agency that would be informed of such plans and studies and that would be in a position to make reports on progress to other interested persons. Problems related to better coordination of instruction in mathematics at the various levels and better coordination of professional activities directed toward the improvement of this instruction were considered. The conference pointed out that the National Council of Teachers of Mathematics is the appropriate agency to provide this coordination.

The conference asked that support be sought for curricular understanding with secondary schools on minimum mathematics programs. It was concluded that such a program should permit a high-school graduate to undertake, as his first course in college, a course in analytic geometry and calculus such as that described by the School and College Study on Admission With Advanced Standing. It was further recommended that the offering of a course in analytic geometry and calculus in high schools was desirable. The need for higher mathematical literacy on the part of all high-school students was also recognized.

The work of professional groups presently engaged in the study of mathematics instruction was endorsed by the conference, and these groups were urged to continue their important activities. The conference revealed that there were in progress a substantial number of studies of real promise, that much remains to be done, and that it is important for the recommendations of these groups to be made known widely and at an early date.

JOHN R. MAYOR
AAAS Science Teaching Improvement Program

Meeting Notes

■ The American Society for Testing Materials has announced the formation of a subcommittee to study the effects of nuclear and high-energy radiation on the properties of plastics and electric insulation. Chairman of the new subcommittee is D. S. Ballantine of Brookhaven National Laboratory.

At the first meeting of the group in St. Louis, on 16 Oct., the chairman emphasized the great need for standardization in the field of radiation effects. The data already existing in the field of radiation effects on materials are in many cases confusing, and instances of outright contradictions are not uncommon. This con-

dition prevails in part because (i) different sources of radiation are employed, (ii) different methods are used to determine and express the radiation doses that have been received, (iii) the irradiations are conducted under differing conditions of atmosphere, temperature, and time, and (iv) different test methods are used to evaluate the results.

It is the prime objective of this new subcommittee to establish, where possible, standard methods of irradiation and standard methods for determining the effects of radiation on the physical and chemical properties of plastics and electric insulation. The subcommittee on radiation effects sponsored jointly by ASTM Committee D-20 on Plastics, F. W. Reinhart, chairman, and Committee D-9 on Electrical Insulating Materials, H. K. Graves, chairman, has established sections to work in the following areas: nomenclature and definitions, dosimetry, correlation of various sources of radiation, total dosage and dose-rate effects, and postirradiation effects. Anyone interested in assisting the work of this committee is invited to write to the chairman, D. S. Ballantine, at Brookhaven National Laboratory, Upton, N.Y.

■ Amino-acid malnutrition in animals and man will be the subject of the 13th annual Conference on Protein Metabolism to be held at Rutgers University, 25–26 Jan. The speakers will be J. S. Garrow, Tropical Metabolism Research Unit, Jamaica, B.W.I.; W. H. Sebrell, Jr., Williams-Waterman Fund; N. S. Scrimshaw, Institute of Nutrition of Central America and Panama, Guatemala; E. E. Howe, Merck and Company; D. B. Tower, National Institutes of Health; and J. B. Allison, Rutgers University.

Among the subjects to be discussed are sulfur-35 methionine uptake in protein-depleted Jamaican children, amino-acid malnutrition as a world problem, amino-acid supplementation in Central American children, amino-acid mixtures for human use, amino-acid metabolism of the epileptogenic cerebral cortex, and repletion of protein-depleted animals. There will be ample time for questions and discussion from the floor. For further information write to William H. Cole, Rutgers University, New Brunswick, N.J.

■ A Symposium on Personnel, Training, and Human Engineering Research was held at the National Academy of Sciences in Washington, D.C., 15–16 Nov. Jointly sponsored by the Air Research and Development Command (ARDC) and the National Research Council of the National Academy of Sciences, the symposium included 28 technical papers in the personnel, training, and human-engineering research field. The following psychologists were chairmen of the sessions: William A. Hunt, Northwestern University; Roger W. Russell, executive secretary, American Psychological Association; Arthur J. Riopelle, Emory University; and Lyle H. Lanier, University of Illinois.

As the second symposium of its kind, this meeting was designed to give Air Force scientists an opportunity to demonstrate how work on Air Force problems contributes to the total body of scientific knowledge. Presentation of each paper was followed by open discussion. Plans call for the publication of the papers in a bound volume that will be available from the National Research Council.

■ The 52nd annual meeting of the American Trudeau Society, medical section of the National Tuberculosis Association, will be held in Kansas City, Mo., 6–9 May, in conjunction with the annual meeting of the National Tuberculosis Association. In addition to scientific sessions at which papers will be presented on current research, plans are being made for seven special lectures and four panel discussions. Topics for the latter will be tuberculin testing, fungous diseases, tuberculosis case finding, and the surgical approach to the bad chronic case of tuberculosis. The lectures will be on cor pulmonale, chest injuries, hazards of radiation, tuberculosis in animals, histologic studies in smoking, mucovisidosis, and diseases of the diaphragm.

Papers for the scientific sessions will be selected from abstracts submitted to the Medical Sessions Program Committee *prior to 8 Jan.* Six copies of the abstracts should be sent to Dr. Edward J. Welch, chairman, 1101 Beacon St., Brookline 46, Mass.

■ A commemorative dinner to mark the silver anniversary of the founding of the Gordon Research Conferences will be held at the Hotel Commodore, New York, on 27 Dec. This date was selected to coincide with the AAAS annual meeting. The principal speaker at the dinner will be Nobel prize winner Glenn T. Seaborg, who will discuss "The future through science." Reservations ($10 a person, $100 per 10-guest table) may be made through Dr. W. George Parks, University of Rhode Island, Kingston, R.I., or W. Alec Jordan, 270 Park Ave., New York 17.

Society Elections

■ Mineralogical Society of America: pres., D. Jerome Fisher, University of Chicago; v. pres., George E. Goodspeed, University of Washington; sec., C. S. Hurlbut, Jr., Harvard University; treas., Earl Ingerson, U.S. Geological Survey.

■ Nature Conservancy: pres., Richard H. Goodwin, Connecticut College; v. pres., F. Raymond Posberg; sec., Elting Arnold; treas., G. Flippo Gravatt, U.S. Plant Industry Station.

■ American Pharmaceutical Association: (to take office 27 Apr.): pres.-elect, Joseph B. Burt, Lincoln, Neb.; 1st v. pres.-elect, J. Warren Lansdowne, Indianapolis, Ind.; 2nd v. pres.-elect Leroy A. Weidle, Sr., St. Louis, Mo.

■ Society for Industrial and Applied Mathematics: pres., Thomas H. Southard, University of California, Los Angeles; sec., Donald B. Houghton, P.O. Box 7541, Philadelphia; asst. sec., Samuel S. McNeary, Drexel Institute of Technology; treas., Robert J. Bickel, Drexel Institute of Technology. The vice presidents are Brockway McMillan, Bell Telephone Laboratories, Inc., and Donald L. Thomsen, International Business Machines.

Forthcoming Events

December

26–31. American Assoc. for the Advancement of Science, annual, New York, N.Y. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 56 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Academy Conference (L. Taylor, West Virginia Univ., Morgantown). 29–30 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (M. Meister, Bronx High School of Science, New York 68). 27 Dec.

AAAS-Gordon Research Conferences (W. G. Parks, Univ. of Rhode Island, Kingston). 27 Dec.

Alpha Chi Sigma (H. G. Seavey, 30 Church St., Room 340, New York 7). 28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. E. Sobel, Jewish Hospital of Brooklyn, Brooklyn 16, N.Y.).

American Assoc. of Hospital Consultants (E. D. Barnett, School of Public Health, Columbia Univ., New York 32.)

American Assoc. of Scientific Workers (R. J. Rutman, 6331 Ross St., Philadelphia 44, Pa.). 29 Dec.

American Astronomical Soc. (J. A. Hynek, Harvard College Observatory, Cambridge 38, Mass.). 26–29 Dec.

American Documentation Inst. (J. Hilsenrath, National Bureau of Standards, Washington 25). 27–29 Dec.

American Educational Research Assoc. (A. G. Wesman, Psychological Corp., 522 Fifth Ave., New York 36). 29 Dec.

American Meteorological Soc. (R. J. Roth, Crop-Hail Insurance Actuarial As-

soc., 209 W. Jackson Blvd., Chicago, Ill.). 28 Dec.

American Museum of Natural History (G. Reekie, AMNH, Central Park West at 79 St., New York, N.Y.). 26 Dec.

American Nature Study Soc. (R. L. Weaver, Univ. of Michigan, Ann Arbor). 26–30 Dec.

American Philosophical Assoc., Eastern Div. (J. Wild, Harvard Univ., Cambridge 38, Mass.). 27 Dec.

American Psychiatric Assoc. (B. Pasamanick, Ohio State Univ., Columbus 10). 28–29 Dec.

American Soc. of Hospital Pharmacists (G. E. Archambault, U.S. Public Health Service, Washington 25). 29 Dec.

American Soc. of Range Management (F. G. Renner, Soil Conservation Service, U.S. Dept. of Agriculture, Washington 25). 28 Dec.

American Statistical Assoc. (R. E. Johnson, Western Electric Co., New York 7).

Association for Computing Machinery (J. P. Nash, Univ. of Illinois, Urbana).

Association of American Geographers (P. M. Stern, Conservation Foundation, 30 E. 40 St., New York, N.Y.).

Astronomical League (H. B. Davidson, 812 Park Ave., New York 21.)

Conference on Scientific Editorial Problems (J. G. Adashko, Ford Instrument Co., Long Island City, N.Y.). 26–28 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 26 Dec.

Ecological Soc. of America (M. F. Buell, Rutgers Univ., New Brunswick, N.J.). 26–30 Dec.

Entomological Soc. of America (P. W. Oman, Plant Industry Sta., Beltsville, Md.). 27–30 Dec.

Genetics Soc. of America (A. W. Pollister, Columbia Univ., New York 27). 28 Dec.

History of Science Soc. (Miss P. Kibre, Hunter College, New York, N.Y.). 27–29 Dec.

Honor Soc. of Phi Kappa Phi (L. R. Guild, 634 So. Western Ave., Los Angeles 5, Calif.). 28–29 Dec.

Institute of Mathematical Statistics (Miss E. Scott, Univ. of California, Berkeley 4).

International Council for Exceptional Children (M. H. Fouracre, Columbia Univ., New York 27). 26 Dec.

International Union for the Study of Social Insects, North American Section (T. C. Schneirla, American Museum of Natural History, Central Park West at 79 St., New York, N.Y.). 26–27 Dec.

Mountain Lake Biological Sta. (B. D Reynolds, Univ. of Virginia, Charlottesville).

Mycological Soc. of America (L. S. Olive, Columbia Univ., New York 27). 26 Dec.

National Acad. of Economics and Political Science (D. P. Ray, George Washington Univ., Washington, D.C.). 27 Dec.

National Assoc. for Gifted Children (Miss A. F. Isaacs, 409 Clinton Springs Ave., Cincinnati, Ohio).

National Assoc. for Research in Science Teaching (N. Washton, Queens College, Flushing 67, L.I., N.Y.). 27 Dec.

National Assoc. of Biology Teachers (J. Breukelman, State Teachers College, Emporia, Kan.). 26–30 Dec.

National Assoc. of Science Writers (J. E. Pfeiffer, New Hope, Pa.).

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 29 Dec.

National Speleological Soc. (Brother G. Nicholas, LaSalle High School, Cumberland, Md.). 29 Dec.

New York Acad. of Sciences (R. F. Nigrelli, New York Zoological Soc. and M. Kopac, New York Univ., Washington Sq., New York, N.Y.). 29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Case Inst. of Technology, Cleveland, Ohio). 29–30 Dec.

Pi Gamma Mu (B. H. Williams, Industrial College of the Armed Forces, Washington 25). 26 Dec.

Scientific Research Soc. of America (D. B. Prentice, Yale Univ., New Haven, Conn.). 26–27 Dec.

Sigma Delta Epsilon (C. Chandler, Boyce Thompson Inst. for Plant Research, 1086 N. Broadway, Yonkers 3, N.Y.).

Sigma Pi Sigma (M. W. White, Pennsylvania State Univ., University Park).

Society for the Advancement of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, 2109 Broadway, New York, N.Y.). 29 Dec.

Society for the Advancement of General Systems Theory (L. von Bertalanffy, Mt. Sinai Hospital, Los Angeles 48, Calif.). 29–30 Dec.

Society for the Study of Evolution (H. Lewis, Univ. of California, Los Angeles 24). 27–29 Dec.

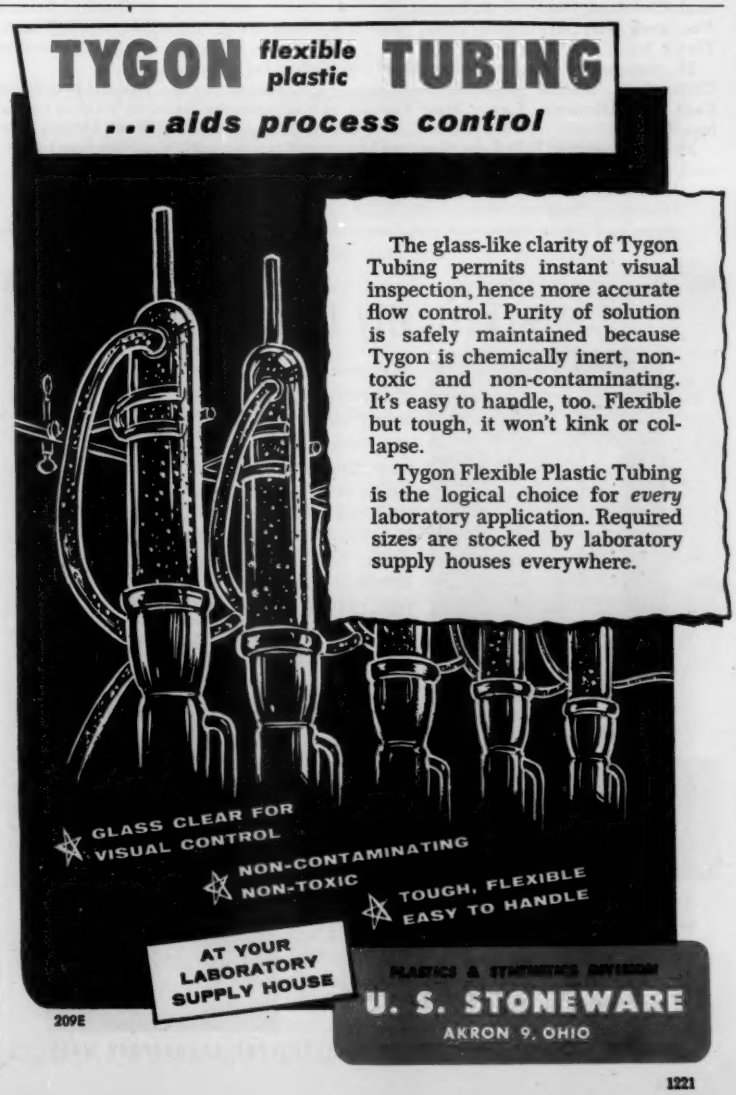
Society of General Physiologists (A. Shanes, National Institutes of Health, Bethesda, Md.).

Society of Systematic Zoology (R. E. Blackwelder, Box 500, Victor, N.Y.). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, Yale Univ., New Haven, Conn.). 27 Dec.

Society of Vertebrate Paleontology, annual (J. T. Gregory, Peabody Museum of Natural History, Yale Univ., New Haven, Conn.). 28–30 Dec.

Torrey Botanical Club (David Keck, New York Botanical Garden, Bronx Park, New York 58). 26–27 Dec.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United Chapters of Phi Beta Kappa (C. Billman, PBK, 1811 Q St., NW, Washington 6). 27 Dec.

27–28. Fluid Mechanics in Chemical Engineering, American Chemical Soc., Lafayette, Ind. (W. E. Ranz, Dept. of Engineering Research, Pennsylvania State Univ., University Park.)

27–28. Northwest Scientific Assoc., 30th annual, Seattle, Wash. (R. B. Walker, Botany Dept., Univ. of Washington, Seattle 5.)

27–29. American Mathematical Soc., 63rd annual, Rochester, N.Y. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

27–29. American Physical Soc., Monterey, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

27–29. Western Soc. of Naturalists, annual, Goleta, Calif. (D. Davenport, Santa Barbara College, Goleta.)

27–30. American Economic Assoc., annual, Cleveland, Ohio. (J. W. Bell, 629 Noyes St., Evanston, Ill.)

27–30. American Finance Assoc., annual, Cleveland, Ohio. (G. E. Hassett, Jr., New York Univ., 90 Trinity Place, New York 6.)

28. Society for the Advancement of Criminology, annual western, Fresno, Calif. (W. Dienstein, Fresno State College, Fresno.)

28–29. American Folk-Lore Soc., annual, Santa Monica, Calif. (MacE. Leach, Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

28–30. American Anthropological Assoc., annual, Santa Monica, Calif. (W. S. Godfrey, Jr., Logan Museum, Beloit College, Beloit, Wis.)

28–30. American Historical Assoc., annual, St. Louis, Mo. (AHA, Study Room 274, Library of Congress, Washington 25.)

28–30. Archaeological Inst. of America, annual, Philadelphia, Pa. (C. Boulter, Library, Univ. of Cincinnati, Cincinnati 21, Ohio.)

28–30. Industrial Relations Research Assoc., Cleveland, Ohio. (E. Young, Sterling Hall, Univ. of Wisconsin, Madison 6.)

29. Mathematical Assoc. of America, 40th annual, Rochester, N.Y. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

29–30. American Chemical Soc., Div. of Industrial and Engineering Chemistry, Princeton, N.J. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6, D.C.)

January

7–11. International Social Science Council, 3rd gen'l. assembly, Paris, France. (Secretary Gen'l., ISSC, 19, avenue Kleber, Paris 16.)

10. Technical and Clinical Applications of Radioisotopes, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

10–12. American Group Psychotherapy Assoc., 14th annual, New York, N.Y. (C. Beukenkamp, Jr., AGPA, Room 300, 345 E. 46 St., New York 17.)

14–16. Cottonseed Processing as Related to the Nutritive Value of the Meal, 4th conf., New Orleans, La. (Southern Regional Research Lab., USDA, 1100 Robert E. Lee Blvd., New Orleans 19.)

14–16. Reliability and Quality Control in Electronics, 3rd natl. symp., Washington, D.C. (C. M. Ryerson, Radio Corp. of America, Bldg. 10–6, Camden 2, N.J.)

14–18. Society of Automotive Engineers, annual, Detroit, Mich. (Meetings Div., SAE, 29 W. 39 St., New York 18.)

14–20. Indian Science Cong. Assoc., 44th meeting, Calcutta, India. (General Secretary, ISCA, 1 Park St., Calcutta 16.)

15. Society for Applied Spectroscopy, Philadelphia, Pa. (F. M. Biffen, Johns-Manville Research Center, Manville, N.J.)

16–23. Australian and New Zealand Assoc. for the Advancement of Science, 32nd meeting, Dunedin, N.Z. (J. R. A. McMillan, ANZAAS, Science House, 157 Gloucester St., Sydney, N.S.W., Australia.)

17. Constructive Medicine in Aging: Cardiovascular Disorders in the Aged, symp., Cincinnati, Ohio. (J. B. Chewning, Wm. S. Merrell Co., Cincinnati 15.)

17–18. Engineers Joint Council, New York, N.Y. (EJC, 29 W. 39 St., New York 18.)

18–19. Symposium on Blood, 6th annual, Detroit, Mich. (W. H. Seegers, Wayne State Univ. Coll. of Medicine, Detroit 7.)

21–22. Solar Furnace Design and Operation, Phoenix, Ariz. (J. I. Yellott, Assoc. for Applied Solar Energy, 3424 N. Central Ave., Phoenix.)

21–25. American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 39 W. 39 St., New York 18.)

23–25. Very Low Frequency Electromagnetic Waves, symp., Boulder, Colo. (J. R. Wait, National Bureau of Standards, Boulder.)

24–25. Western Spectroscopy Assoc., 4th annual, Los Angeles, Calif. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)

25. Bibliographical Soc. of America, New York, N.Y. (H. W. Liebert, Yale Univ. Library, New Haven, Conn.)

25–26. Protein Metabolism, 13th annual conf., New Brunswick, N.J. (W. H. Cole, Rutgers Univ., New Brunswick, N.J.)

28–29. Many Body Problem, symp., Hoboken, N.J. (G. J. Yevick, Dept. of Physics, Stevens Inst. of Technology, Hoboken.)

28–31. American Meteorological Soc., New York, N.Y. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

28–31. Modern Methods of Analytical Chemistry, 10th annual symp., Baton Rouge, La. (P. W. West, Louisiana State University, Baton Rouge.)

30–1. American Assoc. of Physics Teachers, New York, N.Y. (F. Verbrugge, Carleton College, Northfield, Minn.)

(*See issue of 16 November for comprehensive list*)

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■ HART PRESS that produces pressures up to 150,000 lb/in² includes a cylindrical pressure chamber of high-alloy steel, two hand pumps, an intensifier, screw press, two connection blocks, two balanced end valves, and a division block. One hand pump activates the intensifier, which operates at a ratio of 1 to 30. The other serves to fill the system with high-pressure oil. (North American Philips Co., Dept. S76)

■ RECORDING OSCILLOGRAPH produces a record that is instantly visible, readable, and usable without processing. The new Visicorder, which will be available during the first quarter of 1957, has a frequency response from direct current to 2000 cy/sec without the use of peaked amplifiers; its sensitivity is comparable to that of photographic-type oscillographs. There are six channels as well as two timing traces. Deflection is 6 in. peak to peak. Record speeds are 0.2, 1, 5, and 25 in. per sec, min, or hr. No amplification is required for most applications. (Minneapolis Honeywell, Dept. S62)

■ EXTRACTOR for use with heavier-than-water solvents uses a rotating glass sphere at the liquid-liquid interface to increase the area of the interface. Provision is made for bleeding off concentrated solvent, distilling it, condensing it, and reintroducing it into the extractor reservoir. (Aloe Scientific, Dept. S101)

■ LIGHT SOURCES containing radioisotope-activated phosphors, plastic, glass, or combination assemblies utilize beta-emitting isotopes and deliver peak output in any specified region of the visible spectrum. The hermetically sealed sources are available in various physical forms. (U.S. Radium Corp., Dept. S103)

■ DUST-COUNTING MICROPROJECTOR projects an enlarged image of the microscope's field on a ruled translucent screen that measures 250 by 200 mm. Final magnification is 1000 diameters. (Mine Safety Appliances Co., Dept. S104)

■ POLYETHELENE GLASSWARE, including standard items as well as hydrometer jars, wide-mouth bottles, test tubes, centrifuge tubes, spigots, line valves, graduated cylinders, pipette baskets, and sink traps, is described in a new catalog. (Scientific Glass Apparatus Co., Inc., Dept. S105)

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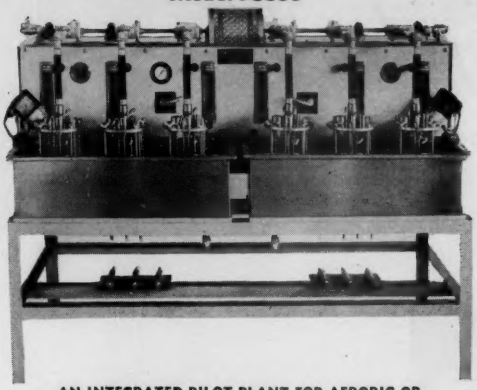

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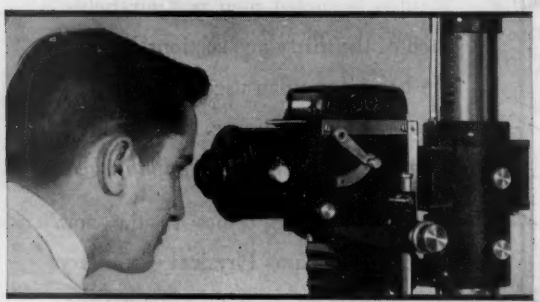

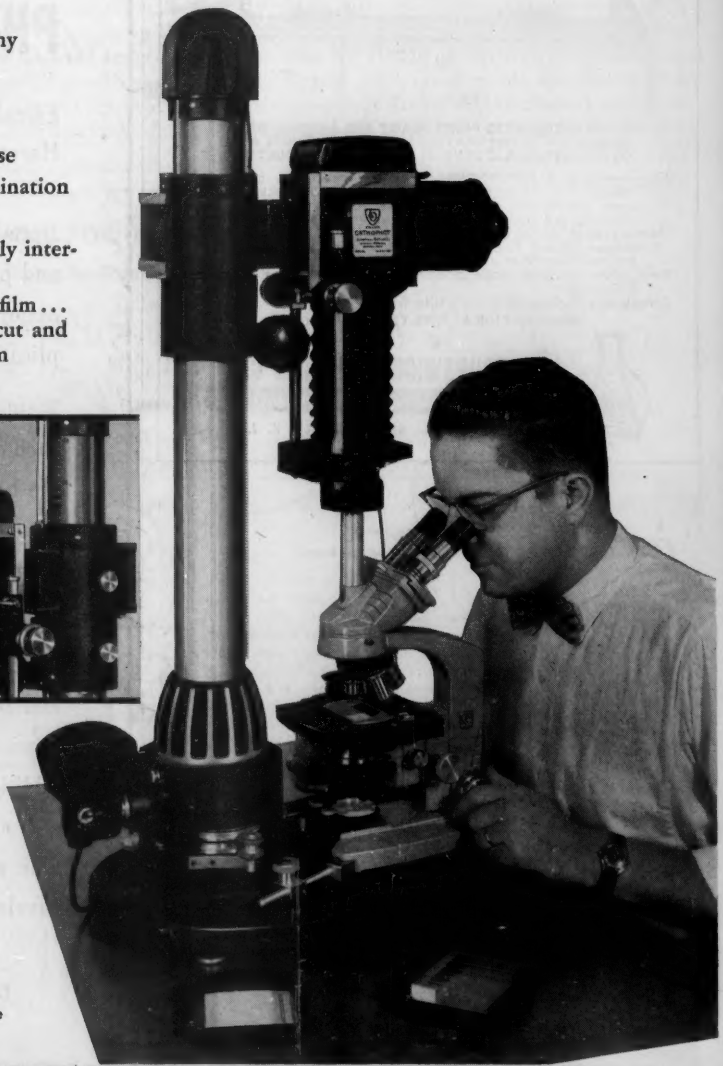

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